ENERGY: MAXIMIZING RESOURCES, MEETING NEEDS AND RETAINING JOBS

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY POLICY, NATURAL RESOURCES AND REGULATORY AFFAIRS

OF THE

COMMITTEE ON GOVERNMENT REFORM

HOUSE OF REPRESENTATIVES

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ENERGY: MAXIMIZING RESOURCES, MEETING NEEDS AND RETAINING JOBS

MONDAY, JUNE 17, 2002

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY POLICY, NATURAL RESOURCES AND REGULATORY AFFAIRS,
COMMITTEE ON GOVERNMENT REFORM,
Peabody, MA.

The subcommittee met, pursuant to notice, at 11 a.m., in Wiggins Auditorium, Peabody City Hall, Peabody, MA, Hon. Doug Ose (chairman of the subcommittee) presiding.

Present: Representatives Ose and Tierney.

Staff present: Dan Skopec, staff director; and Allison Freeman, clerk.

Mr. OSE. Welcome to today's hearing of the Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs here in Peabody, Massachusetts. I want to preface my opening statement by welcoming our witnesses today and thanking Congressman Tierney for suggesting the idea of coming up here. I have searched for 3½ years to find some means of getting John to lean to the right. I had no idea I just had to come up here on the stage. [Laughter.]

The purpose of today's hearing is to consider recommendations to address our Nation's energy challenges. A sound energy policy is essential to all Americans, regardless of whether we are from the East, the South, the Midwest, the Northeast, or the West. Energy supplies are essential to heating and cooling our homes, running our modern technology, moving goods across the country, and fueling our economy. As a resident of California, I have the dubious first-hand knowledge of how important a stable and affordable energy supply is. As you may well realize, over the past few years California has undergone a severe energy crisis. Due to blackouts, increased rates, and high natural gas prices, Californians have suffered mightily as a result of our energy woes.

However, energy is a commodity that most people take for granted, regardless of where you live. Every time you turn your computer on or cook dinner on the stove you use energy. We use energy in these lights; we use energy in these microphones. Most people do not think about where it comes from or how it is produced. However, the issues surrounding energy policy are just as complex and important as in other major public policy arenas. And, unfortunately, we have ignored many of these problems for far too long.

Our current energy system is old and out of date. Most electric utilities are structured the same way they were at the turn of the century, and I challenge you to cite me an example similar in na-

ture. We still rely too much on foreign oil to propel our economy. We have not worked hard enough to encourage renewable energy sources or promote energy efficiency—and as an aside, I do want to tell the people of Peabody that Congressman Tierney is an able and staunch advocate of renewable sources of this nature—and as a consequence, going back to my point, our energy infrastructure is woefully insufficient.

For the first time in a decade, we are finally attempting to modernize our energy policy. In May of last year, President Bush unveiled his National Energy Policy, which is a set of recommendations and goals for Congress to follow. The President's plan represents the most comprehensive approach to energy policy in a generation. The plan balances the need for creating new energy supplies with the goals of improving the efficiency of our energy system in a way that protects the environment and promotes economic growth.

In August 2001, the House passed H.R. 4. This legislation encompassed most of President Bush's priorities. This spring, the Senate passed its version of H.R. 4. The two bills have some significant differences, and we will be looking at those in a Conference Committee this summer and fall, the conferees of which were just appointed this past week.

Let me now point out a few of the highlights in the House bill. Important here in the Northeast, the bill increases funding for the Low-Income Home Energy Assistance Program, LIHEAP, to meet the energy needs during the winter. Interestingly enough, in California, we use LIHEAP funds to help people cool their houses in the summer.

The House bill also includes several provisions to improve energy efficiency in appliances, homes, and office buildings. It expands the Energy Star Program, which is run out of the Department of Energy and the Environmental Protection Agency. The Energy Star label is only awarded to products that significantly exceed the minimum energy efficiency standards. This bill provides tax credits for people who install such technologies in their homes or places of business. The bill also requires all Federal facilities to use energy efficient products and build to the highest standards.

I am especially pleased that the House renewed the tax credit for renewable energy products. Renewable energy, such as geothermal, wind, biomass, and solar, show great promise in contributing to our energy needs. Now, I want to be clear here, I don't want to fool anybody about this, renewable energy is an important component, but it cannot be the only piece to the solution. Now we have an overhead slide in terms of the electricity generation. Fact of the matter is we need to promote biomass and wind and these others wherever we can.

In Sacramento Valley, we produce a lot of rice. Rice straw is a waste product of the rice growing process. The reality is we have a lot of rice straw leftover after we harvest the rice. And one of the things in H.R. 4 that we do is we create a tax credit for open-loop biomass products like rice straw. So instead of burning the straw, we can convert it into energy and produce electricity.

The House bill also increases the fuel economy of light duty trucks in an effort to save 5 billion gallons of gasoline over the cur-

rent standards that are in place. The House bill encourages the development of alternative fuel or hybrid vehicles by increasing the requirement on the Federal Government to purchase vehicles, providing grants to State and local governments to purchase those vehicles, providing large tax credits for individuals and businesses that do purchase such products.

Now, these are just a few of the things that were in H.R. 4, and we are going to try to improve it in the Conference Committee. One of the purposes of this hearing is to allow Congressman Tierney and I to take some input back to Washington for the purpose of engaging in that conversation.

Now, I do want to speak a little bit about one particular facet of the Senate bill, as opposed to the House bill. The Senate bill requires 5 billion gallons of ethanol to be used nationwide by the year 2012. At present, even with the support of significant Federal subsidies, the Nation only uses about 1.7 billion gallons. At a recent hearing in my subcommittee, energy experts predicted that the Senate ethanol mandate would increase the price of gasoline in non-attainment areas by up to 10 cents per gallon. The Northeast has many areas that are non-attainment in terms of air quality, and that is a cost that the people who live in the Northeast and in California will have to bear.

The reality is that studies have shown that using ethanol is a net energy loss. In other words, it requires about a third more in energy to create ethanol as it does to produce. The Senate ethanol mandate is a massive transfer of wealth from non-ethanol producing States to ethanol producing States, and I would hope that as we consider this provision in the Conference Committee that we would go back to good science and good policy rather than focus so much on politics.

And I do want to welcome our witnesses today. We have an excellent panel, many of whom were suggested by Congressman Tierney. Today's witnesses I will introduce in a moment, but now I would like to yield to Congressman Tierney for the purposes of an opening statement.

[The prepared statement of Hon. Doug Ose follows:]

Chairman Doug Ose
Opening Statement
Energy: Maximizing Resources, Meeting Needs, Retaining Jobs
Peabody, Massachusetts
June 17, 2002

The purpose of today's hearing is to consider recommendations to address our nation's energy challenges. A sound energy policy is essential to all Americans. Whether we are from the East, the South, the Midwest, or the West, energy supplies are essential to heating or cooling our homes, running our modern technology, moving goods across the country, and fueling our economy. As a resident of California, I know firsthand the importance of stable and affordable energy supplies. Over the last few years, California has faced a severe energy crisis. Due to blackouts, increased electricity rates, and high natural gas prices, Californians have suffered mightily as a result of our energy woes.

However, energy is a commodity that most people take for granted. Every time you turn your computer on, or cook dinner on the stove, you use energy. Most people do not think about where energy comes from or how it is produced. However, the issues surrounding energy policy are just as complex and important as in other major public policy arenas. Unfortunately, we have ignored the problems for far too long. Our current energy system is old and out-of-date. Most electric utilities are structured the same way they were at the turn of the century. We still rely too much on foreign oil to propel our economy. We have not worked hard enough to encourage renewable energy sources or promote energy efficiency. And, our energy infrastructure is woefully insufficient.

For the first time in a decade, we are attempting to modernize America's energy policy. In May 2001, President Bush unveiled his National Energy Policy, a set of recommendations and goals for Congress to follow. The President's plan represents the most comprehensive approach to energy policy in a generation. The plan balances the need for creating new energy supplies with the goals of improving the efficiency of our energy system in a way that protects the environment ***and*** promotes economic growth.

In August 2001, the House of Representatives passed, H.R. 4, "Securing America's Future Energy Act of 2001." This legislation encompassed most of President Bush's priorities. This spring, the Senate passed its version of H.R. 4. The two bills have some significant differences, which will be ironed out in a Conference Committee this summer and fall.

Let me now point out a few of the highlights in the House bill. The bill increases funding for the Low Income Home Energy Assistance Program (LIHEAP), to meet the energy needs of low-income Americans. In Massachusetts, this money will help more people keep their homes warm in the winter. Interestingly, in California, LIHEAP funds help people keep their houses cool in the summer.

The House bill also includes several provisions to improve energy efficiency in appliances, homes, and office buildings. It expands the Energy Star program, run by the

Department of Energy and the Environmental Protection Agency. The Energy Star label is only awarded to products that significantly exceed minimum energy efficiency standards. The bill provides tax credits for people who install energy efficiency technologies in their homes or places of business. The bill also requires that all Federal facilities use energy efficient products and build to the highest standards.

I am especially pleased that the House expanded the tax credit for renewable energy products. Renewable energy, such as wind, geothermal, biomass, and solar, shows great promise in contributing to our energy needs. I do not want to fool anyone today. Renewable energy simply cannot replace our existing energy supply. But, we should promote it whenever it is economically feasible. For example, in the Sacramento Valley, we produce a lot of rice. Rice straw is a waste product of the rice-growing process. Traditionally, farmers have burned leftover rice straw. Unfortunately, burning rice straw creates serious air pollution problems in the Sacramento Valley. Wisely, H.R. 4 provides a tax credit for open-loop biomass products, like the rice straw in my district.[1] Now, instead of burning rice straw and creating air pollution, we can turn rice straw into energy and produce electricity.

The House bill also increases the fuel economy of light duty trucks, an effort that will save 5 billion gallons of gasoline over the current standards. The House bill encourages the development of alternative-fuel or hybrid vehicles by increasing the requirement that the Federal government purchase such vehicles, providing grants to State and local governments to purchase such vehicles, and providing large tax credits for individuals and businesses that purchase hybrid or alternative-fuel cars and trucks[2].

These are but a few of the highlights in the House bill, H.R. 4. While I acknowledge that this legislation is not perfect, it represents a great step forward in terms of bringing our energy policy into the 21st Century.

I have focused my comments on the House energy bill. However, I want to make one important point on the Senate energy bill. The Senate bill contains a new subsidy to the ethanol industry that will raise the price of gasoline for consumers in California and Massachusetts. The Senate bill requires 5 billion gallons of ethanol to be used nationwide by the year 2012. Today, despite the fact that ethanol gets generous tax credits, the nation only uses about 1.7 billion gallons. At a recent hearing in my Subcommittee, energy experts predicted that the Senate ethanol mandate would increase the price of gasoline 10 cents per gallon on average. Furthermore, studies have shown that ethanol production is a net energy loss. That is, it takes more energy to produce ethanol than the ethanol is actually worth. Quite simply, the Senate ethanol mandate is a massive transfer of wealth from the ethanol producing states to the non-ethanol producing states. As we consider ways to improve our energy policy, I would hope that Congress avoids costly mandates based on faulty science and a heavy dose of politics.

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[1] Open-loop biomass includes waste products from agriculture.

[2] Fuel cell vehicles: $4000-$40,000; hybrid motor vehicles: $250 - $10,000; lean burn technology vehicles: $1,000-$3,500. Range of figures depends on weight class and fuel efficiency.

I look forward to the witness testimony today. I hope to learn how we can improve the way we supply, use, and conserve our energy resources.

The witnesses for the hearing include: David Fairman, Vice President of International Dispute Resolution, The Consensus Building Institute; Steve Bernow, Energy Group Director, Tellus Institute; George Sterzinger, Executive Director, Renewable Energy Policy Project; Roger Little, CEO, Spire Corporation; and Byron Swift, Director, Energy and Innovation Center, Environmental Law Institute.

Mr. TIERNEY. Thank you very much, Mr. Chairman. I want to just tell the folks from the 6th District that have showed up here today how pleased I am that you have consented to have this hearing in the District. This is a matter of obvious importance to all of us throughout this entire region, and I understand the difficulties that California has had recently, and people here should know the role that you play in trying to resolve some of the issues there and bring about some solutions. We have had any number of hearings now in Washington and in California on the issues that affect not only the State of California but the entire Nation, and we appreciate your commitment and your work in that area, and again appreciate your ability to join us here.

The Senate does have a different version than the House on H.R. 4 in the energy bill. I have to be direct and tell people I wasn't pleased with either bill. I think that the House version certainly needed a lot of refinement, and the Senate bill, while it had some good aspects, like renewable portfolios required, failed to do anything of significance with the CAFE standards, and I think both bills certainly could have had a better distribution of research and development moneys as well as a greater amount of research and development moneys if we really are going to shift our policy in this country.

Congressman Ose is right in saying that we are not instantaneously going to move from fossil fuels to other sources of energy, and I don't think anybody reasonably would try to make the case that we could. But we can in this country take a look forward and look to see where we want to be at a certain point of time and try to move there as quickly as possible so that we can displace as much of the fossil fuel reliance as possible into very reliable and cheaper and cleaner fuels.

So the energy independence, the impact of fossil fuels on our environment and the potential of renewables, alternatives, and energy efficiency to meet our needs while creating jobs, that's of great importance to people here, and I think that's another significant factor, in every change that we have, whether it is in trade or whether it is in energy in other areas, there are some people that will be displaced, most notably in the energy field, there will be people in the coal and oil industries. And we have to consider that as part of our policy planning so that people there have a cushion for the impact on that and get back to employment at the rates that they are employed currently, or as near as possible for their families and for their communities.

In this post-September 11th world, it has become more and more important that the United States achieve independence from the Middle East. For decades, domestic oil prices have risen and fallen on the whim of OPEC. To protect our national security, we cannot continue at the current level of reliance on foreign oil. We need to reform the way we obtain, process, and use energy resources. Each day, 48 percent of the oil consumed by Americans comes from overseas. In fact, in 2000, we spent $380 per person, totaling $106 billion, importing crude oil. We rely so heavily on imports because no new oil fields have been discovered in the United States for decades.

Even drilling in the Arctic National Wildlife Refuge will not solve our energy needs. Experts tell us that ANWR will only contribute a trivial 1 percent to the U.S. share of worldwide oil reserves. That leaves us few options other than continued reliance on foreign imports of oil. If we stay the current course, by 2020 the percentage of oil that is important will grow to 62 percent. And since two-thirds of the world's oil lies in the Middle East, we will be beholden to regimes like those in Saudi Arabia, Iraq, and Iran. And we have the charts down there that show, I think, pretty clearly our energy sources, also the one, the distribution of oil reserves, showing us just from which countries we get our oil.

In addition to the situation in the Middle East, and the large amount of oil that we import there which subjects us to the whims of those nations, Venezuela provides a significant amount of oil to this country and is certainly not a stable situation that is reliable at this point, in my mind. So it is not just the Middle East, it is elsewhere from which we take our oil reserves that we have to be cautious of.

The type of energy that we have used, mostly fossil fuels, has served us well over the past 150 years. We have benefited from a tremendous economic boom and enjoy an unprecedented quality of life. We still, however, know that it has come at the price to our health and to our environment. At the same time, this continued reliance on oil threatens our national security. We are also destroying our environment through the use of fossil fuels. Two weeks ago, the President's Environmental Protection Agency released a report that acknowledges the role of man-made pollutants as a significant source of global warming. The question is no longer over whether warming occurs but rather over the extent, the speed and the magnitude of its effects.

We have both the means and the way to address this dual dilemma. The means to a safe and sound energy future lie in advanced energy-efficient and low carbon technologies, and the way is through smart public policy.

It is time to reduce oil consumption through vehicle efficiency in new fuels. Between 1975 and 1998, Carbon Average Fuel Economy, known as CAFE standards, resulted in nearly doubling new passenger car fuel economy. In 2000 alone, CAFE standards saved the country 60 billion gallons and over $90 billion. This has had a positive effect on our environment and a positive effect on the wallets of drivers when they pull up to the gas pump.

We can also reduce energy consumption by improving the efficiency standards required of commonly used appliances, like air conditioners, refrigerators, photocopiers, and fax machines. Just these standards already on the books are estimated to save consumers over $150 billion in energy costs by 2020.

Even as we improve efficiency, we can also improve our energy independence and help the environment by increasing the use of renewable energy sources. Renewables are available to all Americans no matter where they live. Wind, sun, water, and plants, which can all be converted into energy, can be found in every region of the country, and it is a tremendously popular idea with the public. A Gallop poll that was held in November 2001 showed support of 90 percent for investments in wind and solar power. Elec-

tricity generated by wind turbines is the fastest growing electricity source in the world and is growing at the rate of 25 percent per year. The energy contained in plants and organic matter, biomass, is used to generate electricity, heat homes, fuel vehicles, and provide process heat for industrial facilities, and its exploitation would be a boon to rural economies. The cost of solar power, used to insulate buildings and reduce heating and cooling costs, has fallen by 90 percent since the 1970's. Once recent study predicts that solar panel costs will plunge from $5.12 per watt now to $1.75 per watt by 2020.

We could easily build on these successes but only with increased investment in research and development. The private and public sectors need to work together to achieve this mutually beneficial result. Ultimately, energy research and development is declining, with the U.S. Federal spending plummeting from $6.55 billion in 1978 to under $2 billion in 1998—$6.55 billion in 1978 to $2 billion in 1998. In that year, the President's Committee of Advisors on Science and Technology recommended doubling research and development over 5 years. It said that our programs were, "not commensurate in scope and scale with the energy challenges and opportunities the 21st century will present."

Now, as I mentioned earlier, obviously the transition to significant reliance on other sources of energy and the move away from a fossil fuel dominated lifestyle won't be done instantaneously. Today's hearing will hopefully provide Congress with information on existing sources, their location and quantities, as well as potential replacements and the practical timeframe within which transition might occur.

Although some fear that transforming our energy policies will lead to profit loss and layoffs, we know that doesn't have to be the case. Companies like Dupont, Johnson & Johnson, Suncor Energy, and others are making commitments to energy efficiency and cleaner use goals. More often that not, these goals are being met sooner than the target dates originally set, and the companies are saving and not losing money on those efforts. And with creativity and commitment, workers in the coal industry and others whose livelihoods depend on traditional energy sources can be assisted and retrained to be a vital part of the provision of new energy sources.

So part of the debate, as I mentioned earlier, has to be about putting in place fair and reasonable ways to sustain impacted workers' families and getting people prepared for comparable employment opportunities. By shifting investment to solar, wind, geothermal, biomass, and other renewable energy sources, we will create new job markets for skilled labor, and our witnesses today will flush that idea out significantly.

Transforming our energy policies to best deal with environmental and security concerns won't be easy; they won't happen right away. Still, if we encourage the best technologies and couple their use with implementation of sound standards fairly applied, we can realize a clean, secure energy future. Today's hearing should give us some valuable insight so that our energy policy for the future should look the way it should.

I join the chairman in welcoming all of our witnesses and thanking them for taking time out of their busy schedules to share with

us information that, as Mr. Ose said, we will be happy to utilize as we go back with our committees and on the floor of the House to try and shape the energy bill into a product that we can all be proud of. Thank you.

[The prepared statement of John F. Tierney follows:]

Statement of Rep. John F. Tierney
House Government Reform Committee Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs
June 17, 2002

Mr. Chairman, thank you for holding this hearing in the 6th District. Energy independence, the impact of fossil fuels on our environment and the potential of renewables, alternatives and energy efficiency to meet our needs while creating jobs are of great importance to the people of this district. I am very happy to have the opportunity to explore these issues here today.

In the post-September 11 world, it has become more important than ever for the United States to achieve independence from Middle East oil. For decades, domestic oil prices have risen and fallen at the whim of OPEC. To protect our national security, we cannot continue at our current level of reliance on foreign oil.

We need to reform the way we obtain, process and use our energy resources. Each day, 48% of the oil consumed by Americans comes from overseas. In fact, in 2000, we spent $380 per person, totaling $106 billion, importing crude oil. We rely so heavily on imports because no new oil fields have been discovered in the United States for decades.

Even drilling in the Arctic National Wildlife Refuge will not solve our energy needs. Experts tell us that ANWR will only contribute a trivial one percent to the U.S. share of world oil reserves. That leaves us few options other than continued reliance on foreign imports. If we stay on our current course, by 2020, the percentage of imported oil will grow to 62 percent. And since two-thirds of the world's oil lies in the Middle East, we will be beholden to regimes like those in Saudi Arabia, Iraq and Iran.

The type of energy we have used—mostly fossil fuels—has served us well for some 150 years. We have benefited from a tremendous economic boom and enjoy an unprecedented quality of life for some. Yet we now know that it has all come at a price to our health and our environment.

At the same time as continued reliance on oil threatens our national security, we are also destroying our environment through the use of fossil fuels. Two weeks ago, the President's Environmental Protection Agency released a report that acknowledges the role of man-made pollutants as a significant source of global warming. The question is no longer over whether warming occurs, but rather over the extent, speed and magnitude of its effects.

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Electricity generated by wind turbines is the fastest-growing electricity source in the world and is growing at a rate of 25% per year.

The energy contained in plants and organic matter – biomass – is used to generate electricity, heat homes, fuel vehicles and provide process heat for industrial facilities, and its exploitation would be a boon to rural economies.

The cost of solar power, used to insulate buildings and reduce heating and cooling costs, has fallen by 90% since the 1970s. One recent study predicts that solar panel costs will plunge from $5.12 per watt now to $1.75 per watt by 2020.

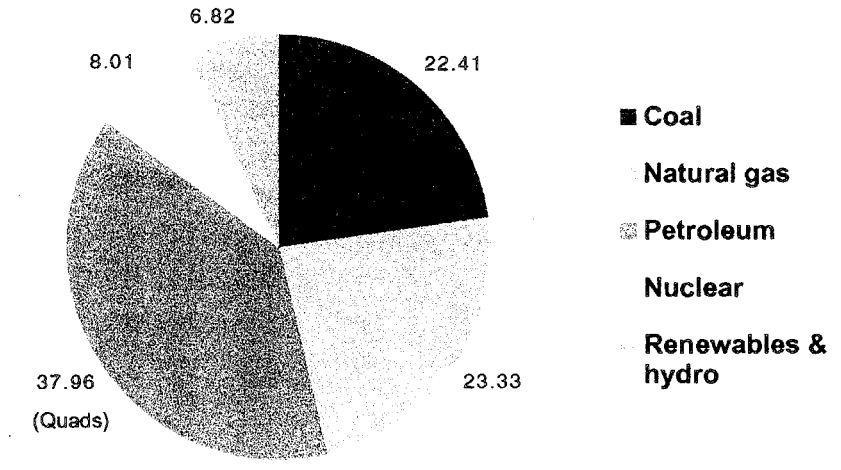
We can easily build on these successes – but only with increased investment in research and development. The private and public sectors need to work together to achieve mutually beneficial results. Unfortunately, energy research and development (R&D) is declining, with U.S. federal spending plummeting from $6.55 billion in 1978 to under $2 billion in 1998. In that year, the President's Committee of Advisors on Science and Technology recommended doubling R&D over 5 years, concluding that our programs were "not commensurate in scope and scale with the energy challenges and opportunities the 21st century will present."

Obviously, the transition to significant reliance on other sources of energy and the move away from a fossil fuel dominated lifestyle will not be instantaneous. Today's hearing will hopefully provide Congress with information on existing sources (their location and quantity) as well as potential replacements and the practical time frame within which transition might occur.

Although some fear that transforming our energy policies will lead to profit loss and layoffs, we know that that does not have to be the case. Companies like Dupont, Johnson & Johnson, Suncor Energy and others are making commitments to energy efficiency and cleaner use goals. More often than not, these goals are being met sooner than the target dates originally set, and the companies are saving, not losing, money on the efforts. And with creativity and commitment, workers in the coal industry and others whose livelihoods depend on traditional energy sources can be assisted and retrained to be a vital part of the provision of new energy sources. (Part of our debate, then, has to be about putting in place fair and reasonable ways to sustain impacted workers' families and getting people prepared for comparable employment opportunities.) By shifting investment to solar, wind, geothermal, biomass and other renewable energy sources, we will create new job markets for skilled labor.

Transforming our energy policies to best deal with environmental and security concerns will not be easy or instantaneous. Still, if we encourage the best technologies and couple their use with implementation of sound standards fairly applied, we can realize a clean, secure energy future. Today's hearing should give us some valuable insight as to what our energy policy for the future should look like.

U.S. Energy Sources



Sources: DOE/EIA

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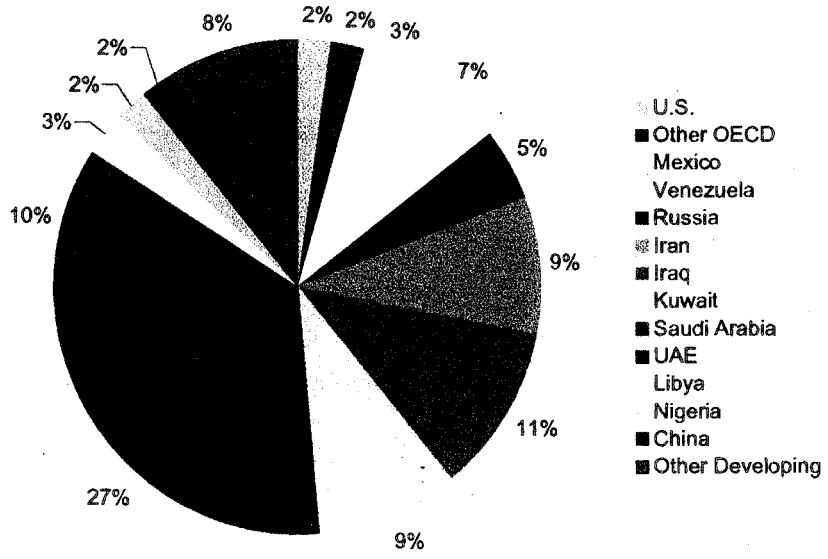
Distribution of Oil Reserves



Source: Oil and Gas Journal

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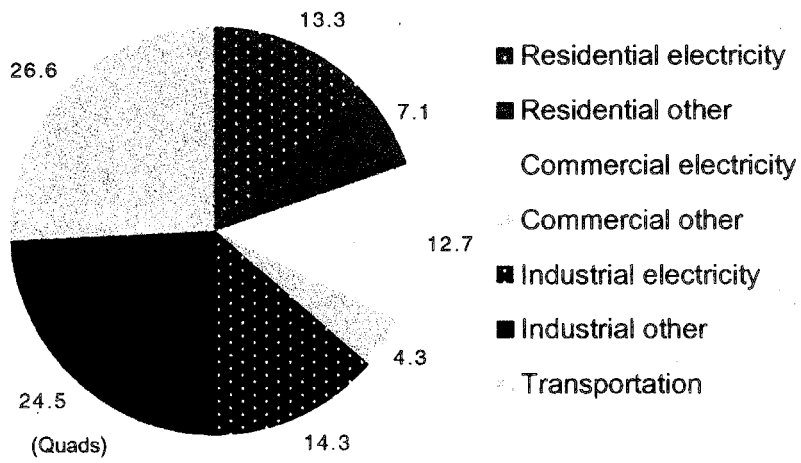
Energy Consumption by Sector



Source: DOE/EIA

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Mr. OSE. Thank you, Congressman Tierney. Just for everybody's benefit, this is a subcommittee of the Committee on Government Reform. When we have a hearing that is an investigative hearing we always swear our witnesses, so we will do that in a moment. We also have in the back of the room, Kara, is that correct? During the course of the hearing, we will have some three by five cards passed out. If you have questions, if you would write them on the cards, we will collect those. And, then, as time permits, we will bring them up here and we will be able to get to them accordingly. That was a request that Congressman Tierney made that I find reasonable, and I concur with that suggestion. Perhaps we should do that in more of our committee hearings, as opposed to us.

So, gentlemen, if you would all rise, we will swear you in. Raise your right hand.

[Witnesses sworn.]

Mr. OSE. Let the record show that the witnesses all answered in the affirmative.

Now, we have five witnesses today. Our first—we are going to introduce them in order. Gentlemen, you are going to be recognized for 5 minutes to summarize your written testimony, which we have read and reviewed. While we don't have a trap door under your chairs, we are jealous of the time, given the press of business today. So if you could constrain yourselves to 5 minutes. You have in front of you a little yellow light and a little red light. The yellow light will come on when you have 1 minute left, and the red light will come on when there are 5 minutes—the yellow light will be on the whole time, the red light will come on when you have no more time.

So our first witness is Stephen Bernow. He is the director of the Energy Group with the Tellus Institute. Mr. Bernow, thank you for joining us. You are recognized. You will have to push the little green button on your microphone. Would the clerk come up here and get the material from Mr. Bernow for the purpose of putting it on the overhead?

STATEMENTS OF STEPHEN BERNOW, DIRECTOR, ENERGY GROUP, TELLUS INSTITUTE; BYRON SWIFT, DIRECTOR, ENERGY AND INNOVATION CENTER, ENVIRONMENTAL LAW INSTITUTE; DAVID FAIRMAN, VICE PRESIDENT, INTERNATIONAL DISPUTE RESOLUTION, THE CONSENSUS BUILDING INSTITUTE; GEORGE STERZINGER, EXECUTIVE DIRECTOR, RENEWABLE ENERGY POLICY PROJECT; AND ROGER LITTLE, CEO, SPIRE CORP.

Mr. BERNOW. Thank you, Chairman Ose and Congressman Tierney, for the opportunity to testify before the subcommittee on the important issue of national energy policy. Recently, I and colleagues at Tellus Institute identified and analyzed a set of targeted national energy policies that over the next 20 years would reduce our Nation's energy demands for fossil fuels in particular and shift to cleaner fuels while maintaining the energy services needed for our national economy and citizens' well-being; reducing greenhouse gas emissions; increasing emissions of local and regional air pollutants that are harmful to human health, the economy, and the environment; reaping net economic benefits; stimulating the introduc-

tion of advanced energy technologies; and maintaining our economic vitality.

These policies would also establish institutional and technological momentum for the far greater reductions in fossil fuel use and greenhouse gas emissions in subsequent decades that are needed to ensure climate stability, the reliability of our energy resources, and the protection of our environment and human health.

The work was embodied in the report, "The American Way to the Kyoto Protocol," commissioned by the Worldwide Fund for Nature and available on the WWF Web site. I understand that my presentation today, "The American Way to the Kyoto Protocol," in the form of overhead transparencies and the text of a paper, "Carbon Abatement with Economic Growth: A National Strategy," based on that report will be incorporated as part of the record of this hearing. Today I will speak briefly, using the overhead transparencies submitted, about the motivation, design, results, and implications of this national energy policy study that we conducted.

The first overhead just gives the title of the study and my colleagues at Tellus Institute. The second informs us, this is the latest in a series of studies that Tellus and collaborators have been doing over the past decade or more. Here, just briefly, is the history of the temperature record in the Northern Hemisphere, showing that we are already at an increase in temperature unprecedented in 1,000 years. And, if you see at the right end, we are going up far greater than that over the next several decades if we don't reverse this business-as-usual policy. By the way, this condition and the condition in which we are entering is unprecedented for about 160,000 years.

On the left, you can see the business-as-usual trajectory of carbon emissions over the next 100 years and the turnaround in that trajectory that will be needed in order to stabilize climate. That is a very daunting challenge. And we can begin to do it now, and sustain it over the next several decades.

The objective of this particular policy study was to see what policy measures can meet the U.S. target set by the Kyoto Protocol for 2010, and to produce steady reductions in greenhouse gas emissions thereafter. The focus is almost exclusively on domestic energy-related policies, but it also assumes some reductions from domestic land-based CO2 and non-CO2 emissions and limited use of international allowances.

These policies, as I said earlier, result in net economic benefits, reduction of air pollutants, and technological innovation. They include in buildings in industrial sectors building codes, equipment standards, and intensity targets, all of which are policies with which we are familiar; a public benefits fund that is a very small tie on electricity sales that would be flowed back into the economy and to households and businesses for energy efficient technologies; improved tax and regulatory treatment for combined heat and power, which is a very dramatic energy-reducing and carbon-reducing policy. In the electric sector, the establishment of a progressive, renewable portfolio standard, reaching 10 percent for non-hydroelectric renewables by 2010 and 20 percent by 2020; and cap and trade systems for criteria air pollutants, those that affect human health and local and regional environments.

In the transportation sector for light duty vehicles, doubling fuel efficiency of new fleets by the year 2020. That is already on the horizon with the new hybrid vehicles. That is increasing the Corporate Average Fuel Efficiency standard to 50 miles per gallon by the fleet that enters service in 2020 and similarly, but not quite as dramatic, improvements in heavy duty truck efficiency and airplane efficiency. It includes a GHG content standard for motor fuels using cellulosic as opposed to starch ethanol. There were comments earlier about the poor energy performance of starch ethanol; it includes using cellulosic ethanol as a blend in gasoline, which does have very promising net carbon emissions, net energy use. Reductions in automobile use associated with increased high-speed rail, based on a DOT study that we elaborated upon, and transit and other modes for urban movement.

This, as you can see, is—the business-as-usual trajectory is the upper bound of that graphic, and with that series of policies, which I have just enumerated, you can see that we can turn energy use around from a relentlessly upward trajectory toward a very dramatic downward trajectory with these policies and with well-known, not exotic, but well-known technologies. Next, please.

It is even more dramatic for carbon because in addition to energy efficiency where these policies will cause a shift toward low or zero carbon fuels, and again no single policy dominates, no single sector dominates, but this suite of policies, some of which are already under discussion in various forms of legislation, can produce this dramatic change. This slide shows the change within the electricity sector itself; again, a very dramatic reduction from a sharp upward trend to a downward trend, actually reducing electricity consumption through energy efficiency and co-generation or combined heat and power very dramatically by 2020, to about half of what it otherwise would have been. Next slide.

This shows the growth, as was discussed earlier, in renewables, under the renewable portfolio standard. The left hand showing business as usual, and the right hand side showing the mix, very strong contribution from wind and biomass, as was discussed earlier. This is what the renewable energy portfolio standard would produce.

These are the net annual costs and savings from these policies. As you can see, the blue line show the annual savings. Within about 2 years of the beginning of their implementation, the annual savings will exceed the annual cost, and that difference will be growing over time over the next 20 years. Next, please.

This shows the annual savings by 2010 and 2020, represented on a per household basis, and you can see by 2020 the net annual savings, that is savings in energy bills over and above the incremental cost of these cutting-edge technologies, will reach close to $1,200 per household in the United States by 2020. Next.

This, finally, through macroeconomic analysis, we flowed all of these changes and energy consumption, energy bill savings for businesses and households through an input/output model, and the result shows that there will be small but important increases in net jobs by the year 2020, about 1.3 million incremental jobs, and associated with that, incremental GNP and incomes. Next, please.

This I won't go into excruciating detail. This shows the job impact sector by sector for those of you who care to read it following this presentation. Please, next slide. And this shows the job impact State by State. Every single State will experience a net job increase, and I urge you to take a look at that in more detail as you come away.

As I said earlier, the modeling shows that not only will energy and carbon be reduced dramatically over the next 20 years but so will each of the major so-called criteria air pollutants which are damaging to human health, the local environment, to crops, forests, and the like. And these show the net result of those policies decreasing each of those emissions. Next, please.

Finally, this is an interesting—I said earlier that we had done a series of studies over the last 10 years. This overhead shows the difference in the results between a study we did 3 years ago of essentially the same set of policy measures and the updated study that we just completed. And it shows the impact of delay, because with the original study we were assuming policies could be implemented in the late 1990's. With the new study that we recently released, the policies couldn't be implemented until, well, maybe next year at the earliest. And the consequence of that is, both with respect to carbon reductions and the net economic savings, there's a substantial reduction. A loss of opportunity by delaying these or similar policies and measures, a loss of opportunity in the needed carbon reductions to help stabilize climate, and a loss of opportunity to begin that technological transition to cutting-edge, modern, efficient, and clean technologies and associated net economic benefits by delaying such policies more than we need to. Thank you.

[The prepared statement of Mr. Bernow follows:]

House Government Reform Committee
Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs
Energy: Maximizing Resources; Meeting Needs; Retaining Jobs
Field Hearing, Peabody, Massachusetts, June 17, 2002

Testimony of Stephen Bernow, Ph.D.
Vice President, Tellus Institute (www.tellus.org),
Boston, MA
Director, Energy Group

Thank you Chairman Ose and Congressman Tierney for the opportunity to testify before the subcommittee on the important issue of national energy policy. Recently, I and colleagues at Tellus Institute, identified and analyzed of a set of targeted national energy policies that, over the next twenty years, would reduce our nation's energy demands (for fossil fuels in particular) and shift to cleaner fuels, while maintaining the energy services needed for our national economy and citizens' well-being, reducing greenhouse gas emissions, decreasing emissions of local and regional air pollutants that are harmful to human health, the economy and the environment, reaping net economic benefits, stimulating the introduction of advanced energy technologies, and maintaining our economic vitality. These policies would also establish institutional and technological momentum for the far greater reductions in fossil fuel use and GHG emissions in subsequent decades that are needed to ensure climate stability, the reliability of our energy resources, and protection of our environment and human heath. This work was embodied in the report *The American Way to the Kyoto Protocol*, commissioned by Worldwide Fund for Nature (WWF) and available on the WWF website.

I understand that my presentation today (*The American Way to the Kyoto Protocol* in the form of overhead transparencies) and the text of a paper (*Carbon Abatement With Economic Growth: A National Strategy*) based on that report will be incorporated as part of the record of this hearing. Today, I will speak briefly, using the overhead transparencies submitted to the record, about the motivation, design, results and implications of this national energy policy study that we conducted.

The American Way to the Kyoto Protocol:
An Economic Analysis to Reduce Carbon Pollution

A Study for World Wildlife Fund

By:
Alison Bailie
Stephen Bernow
William Dougherty
Michael Lazarus
Sivan Kartha

With Marshall Goldberg
MRG & Associates

Tellus Institute and
Stockholm Environment Institute
Boston, MA, USA

April 2002

Latest in a series of national climate policy studies by Tellus and its collaborators….

The aim is to reduce U.S. greenhouse gas emissions, fossil fuel dependence and pollutant emissions.

America's Energy Choices (1991) -- with ACEEE, UCS, ASE, NRDC

Energy Innovations (1996) -- with ACEEE, UCS, ASE, NRDC

Policies and Measures to Reduce CO2 Emissions in the US (WWF 1997; 1998)

America's Global Warming Solutions (WWF 1999)

Meeting America's Kyoto Protocol Targets (1999) -- with ACEEE

Smart Energy Policies (2001) -- with ACEEE

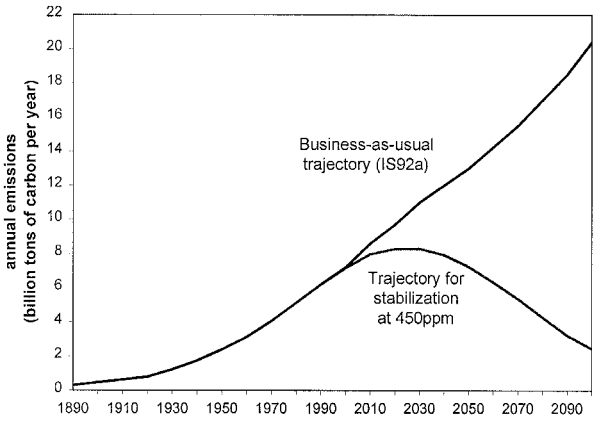
Clean Energy Blueprint (2001) – with UCS

The Challenge of Climate Change

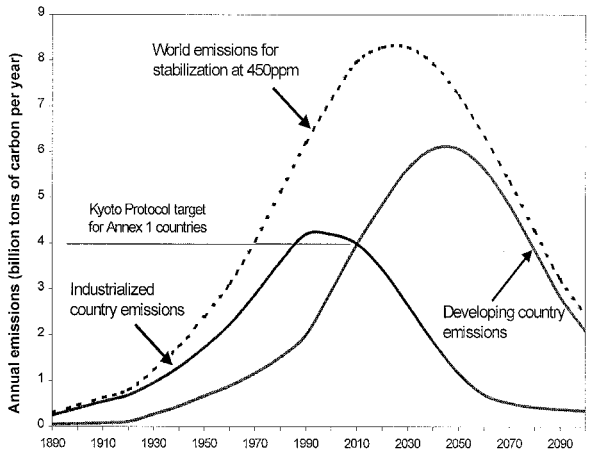
- Mid-range of a business-as-usual path will result in GHG emissions increasing from about 6 billion tons carbon equivalent today to more than 20 billion tons by 2100.
- This will result in atmospheric concentrations to over 700 parts per million, almost 3 times pre-industrial levels, unprecedented for hundreds of millennia.
- The average global temperature would increase of by about 4 to 10 degrees Fahrenheit; even greater changes would occur in some regions.
- With these changes there is the possibility of rapid runaway effects with disastrous and irreversible ecological and social impacts.
- Al alternative path, decreasing annual emissions to about 2 billion tons by 2100, with no more than 450 ppm concentrations, and an average global temperature change of no more than about 4 degrees would help to ensure relative climate and ecological stability.
- This would require the world to decrease from about 1 tonC/capita today to about 0.3 ton C/capita by 2100, despite economic growth.

Global Carbon Emissions for Stabilizing GHG concentrations

Global carbon emissions from fossil fuel combustion with trajectory for stabilization



Carbon emissions for stabilization of GHG concentrations at 450 ppm, broken out by developing and industrialized countries



Where We Are And Where We Need To Go

- The World averages emissions of 1 ton C per capita for 6 billion tons per year.
- The industrialized countries emit about 2 tons C per capita for about 4 billion tons per year, while the developing countries emit about 0.5 tons C per capita for about 2 billion tons per year.
- The US emits almost 6 tons per capita, almost one-quarter of the global total.
- The goal of 0.3 tons per capita is especially daunting to the developing countries, many of whose peoples don't now have access to energy, and to the US, which would need to reduce its emissions several-fold.
- But this could be done with: (1) energy efficient technologies, processes and practices, (2) zero or low carbon energy resources, and (3) reduced energy service needs through system. Thus, necessity can be turned into an opportunity for a technological renaissance and a establishing new and more sophisticated relationship between society and nature.

The American Way to the Kyoto Protocol (WWF 2001)

- The objective is to meet the U.S. Kyoto target for 2010, with continued steady reductions thereafter.
- The focus is on domestic energy-based policies …
- But assumes some reductions from domestic land-based CO_2 and non-CO_2 emissions, and limited purchase of international allowances to meet the 2010 target.
- The policies result in economic benefits, reduction of local air pollutants, and technological progress.

Domestic Energy-based Actions

Buildings and Industrial Sectors

- Building codes, Equipment Standards, Intensity targets
- Public benefits fund, RD&D, Tax incentives
- Improved tax and regulatory treatment of Combined Heat and Power (doubling by 2010, almost 4 fold increase by 2020)

Electric Sector

- Renewable Portfolio Standard (10% non-hydro renewables by 2010, 20% by 2020)
- Cap and trade systems for SO_2, NO_x, and CO_2

Domestic Energy-based Actions (continued)

Transportation Sector

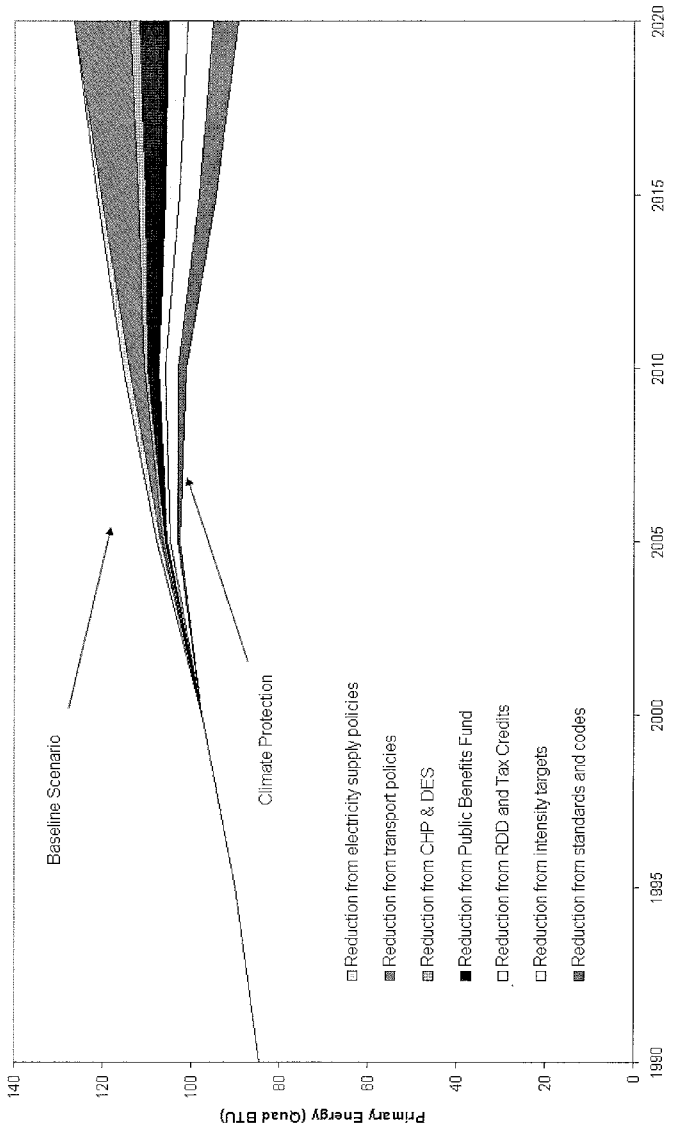
- Increased fuel efficiency (improvement over current levels)

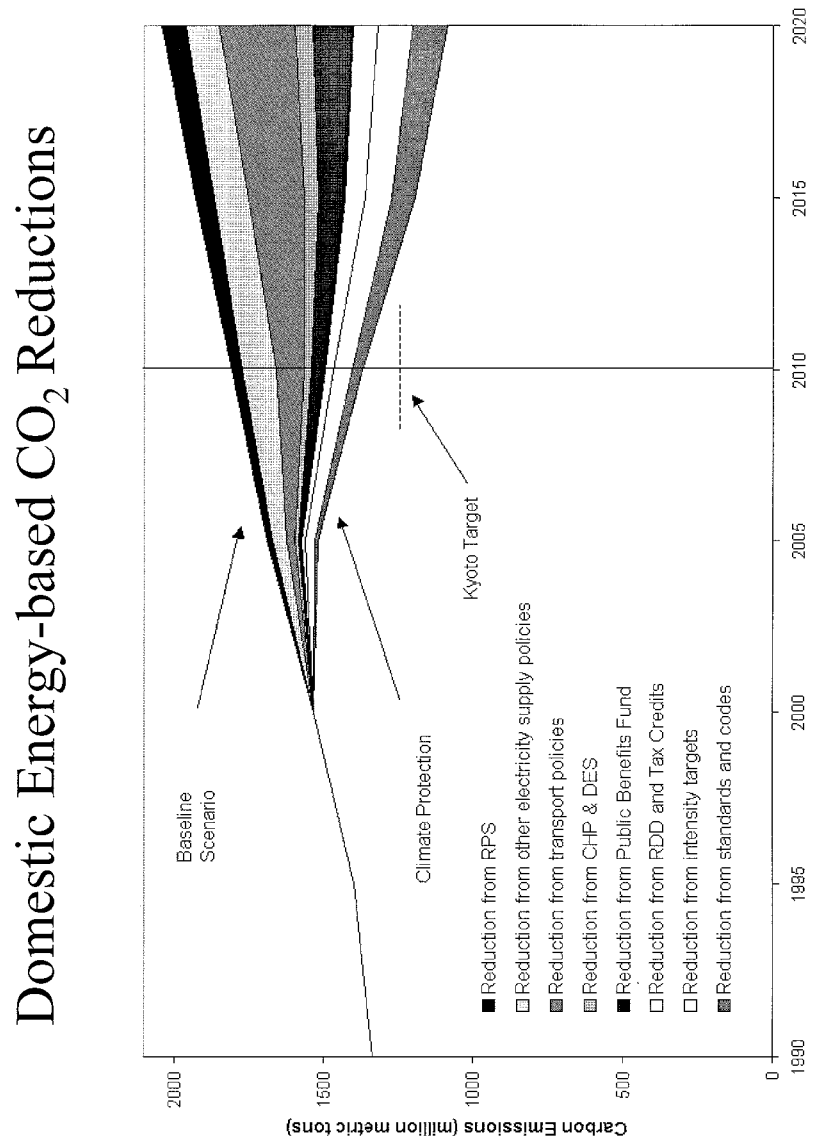
	by 2010	by 2020
light duty vehicles	45%	100%
heavy duty trucks	6%	23%
airplanes	23%	53%

- GHG content standards for motor fuels (cellulosic ethanol provides 3.5% of fuel for light duty vehicles in 2010, increasing to 7% in 2020)

- Reductions in automobile use (increased high speed rail, transit and other modes)

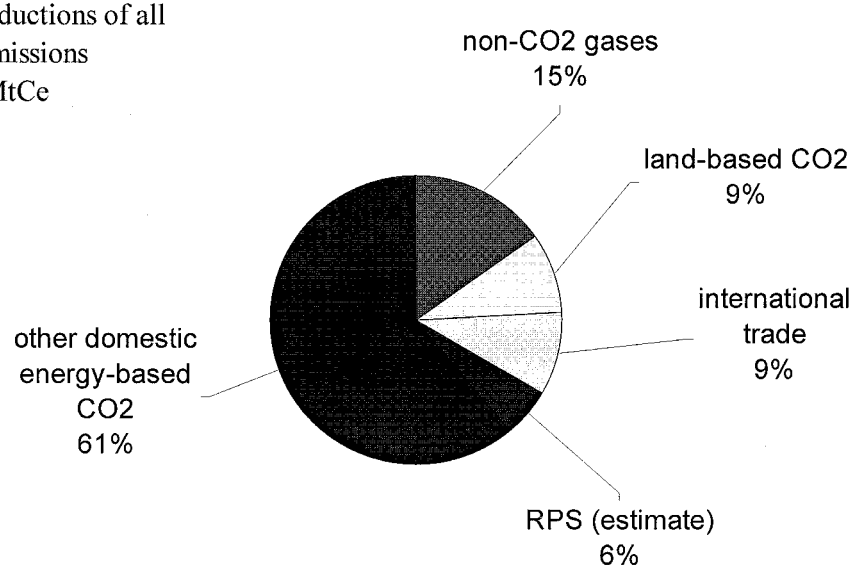
Domestic Primary Energy Reductions



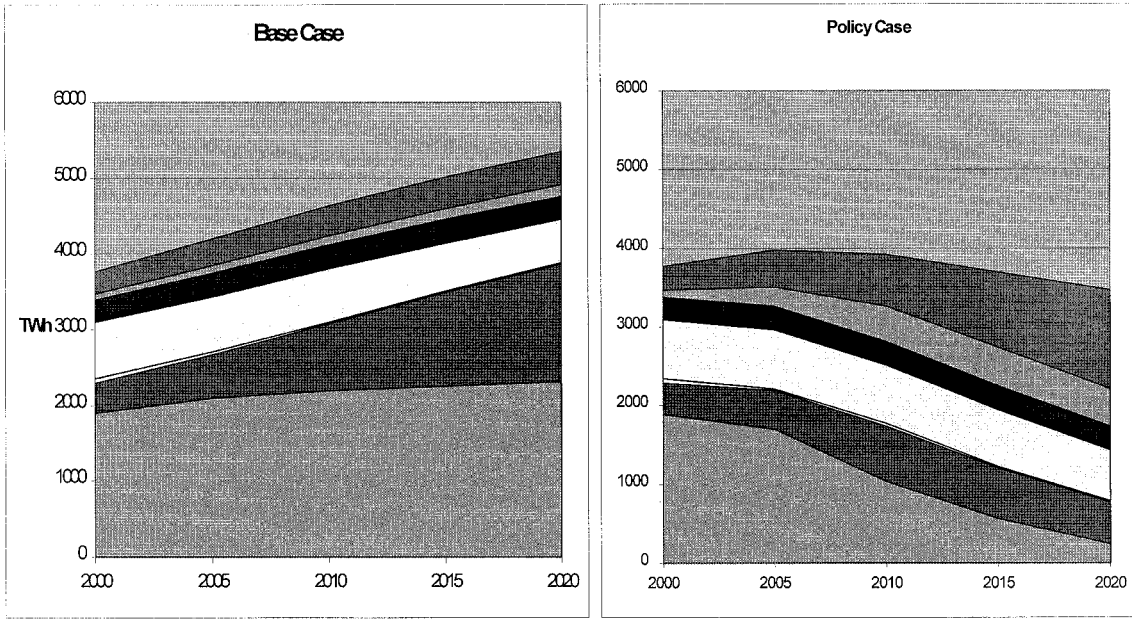

Domestic Energy-based CO_2 Reductions
Carbon Emissions (million metric tons)
2000
1500
1000
500
0
1990
1995
2000
2005
2010
2015
2020
Baseline Scenario
Climate Protection
Kyoto Target
Reduction from RPS
Reduction from other electricity supply policies
Reduction from transport policies
Reduction from CHP & DES
Reduction from Public Benefits Fund
Reduction from RDD and Tax Credits
Reduction from intensity targets
Reduction from standards and codes

Carbon Reductions in 2010 to meet Kyoto Target

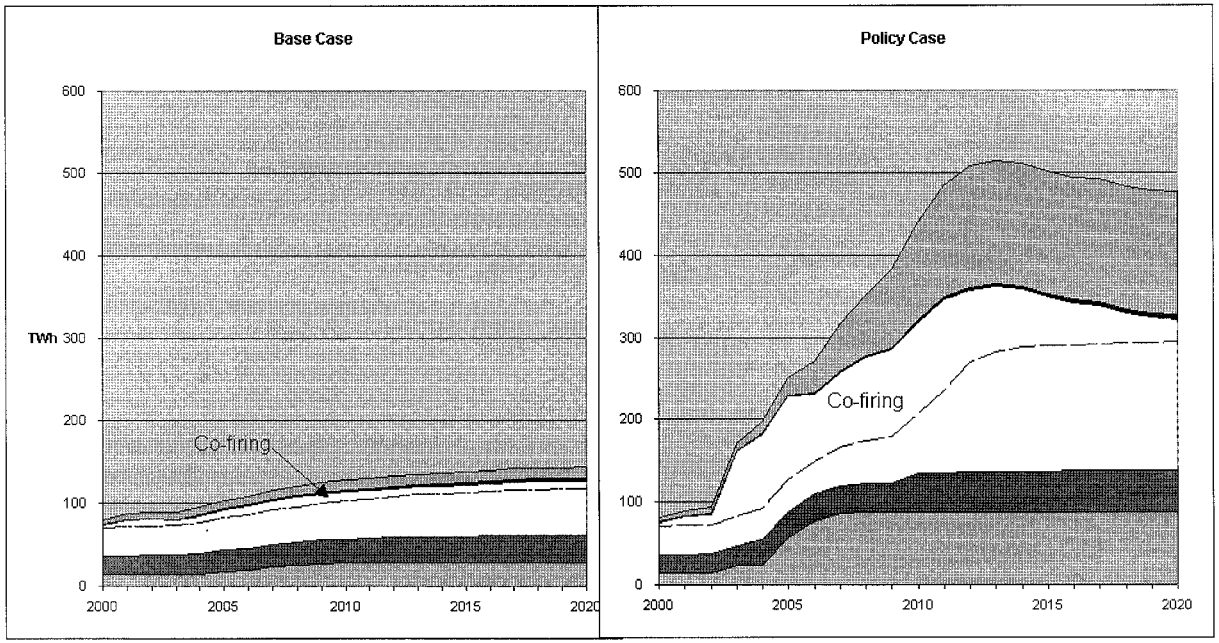
Total reductions of all GHG emissions 654 MMtCe



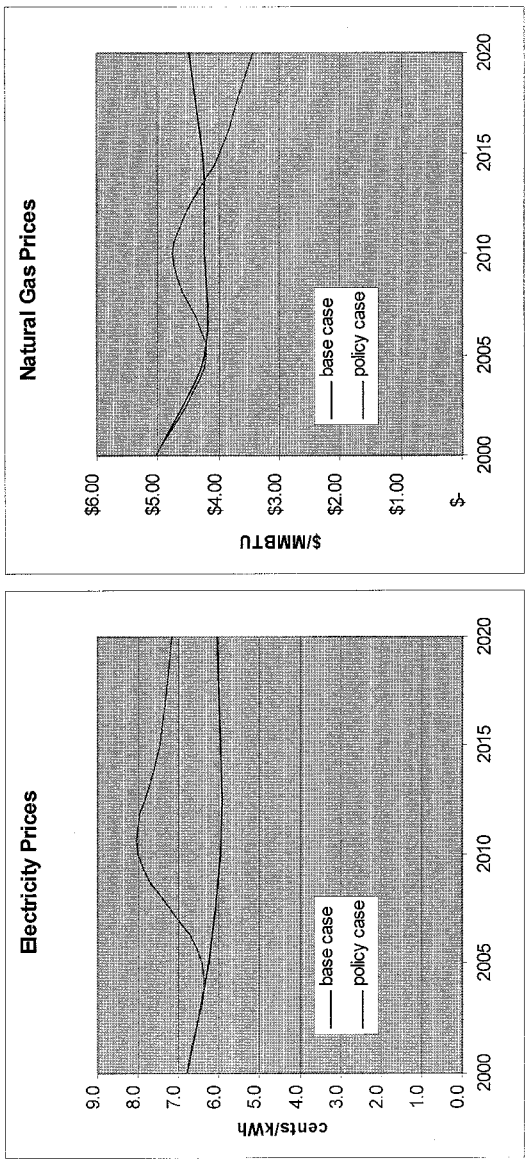
Total Electricity Generation



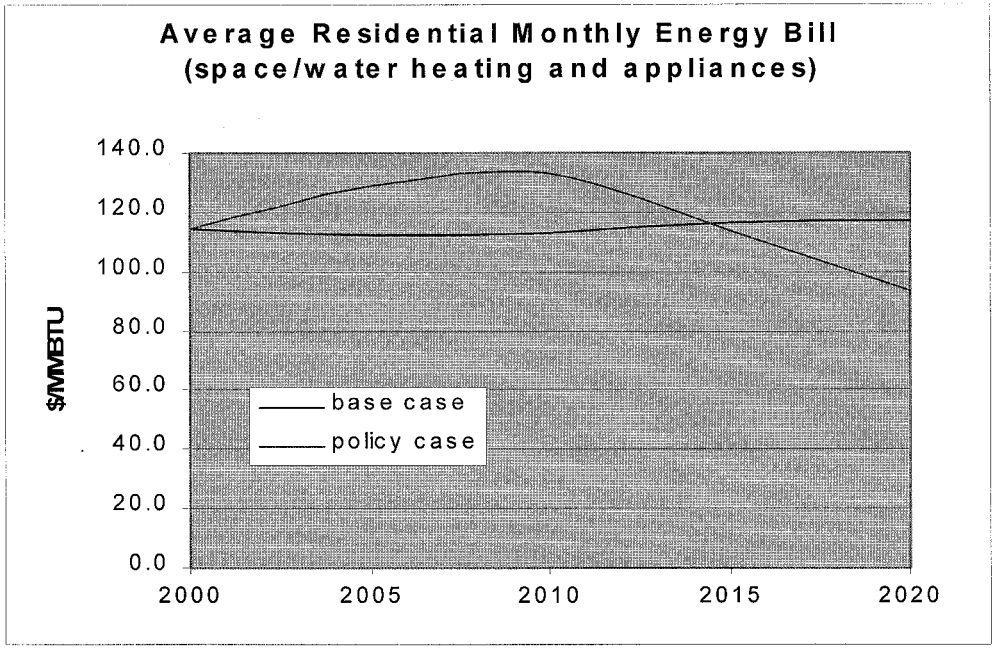
Generation by Renewables



Energy Prices
(average across all sectors)

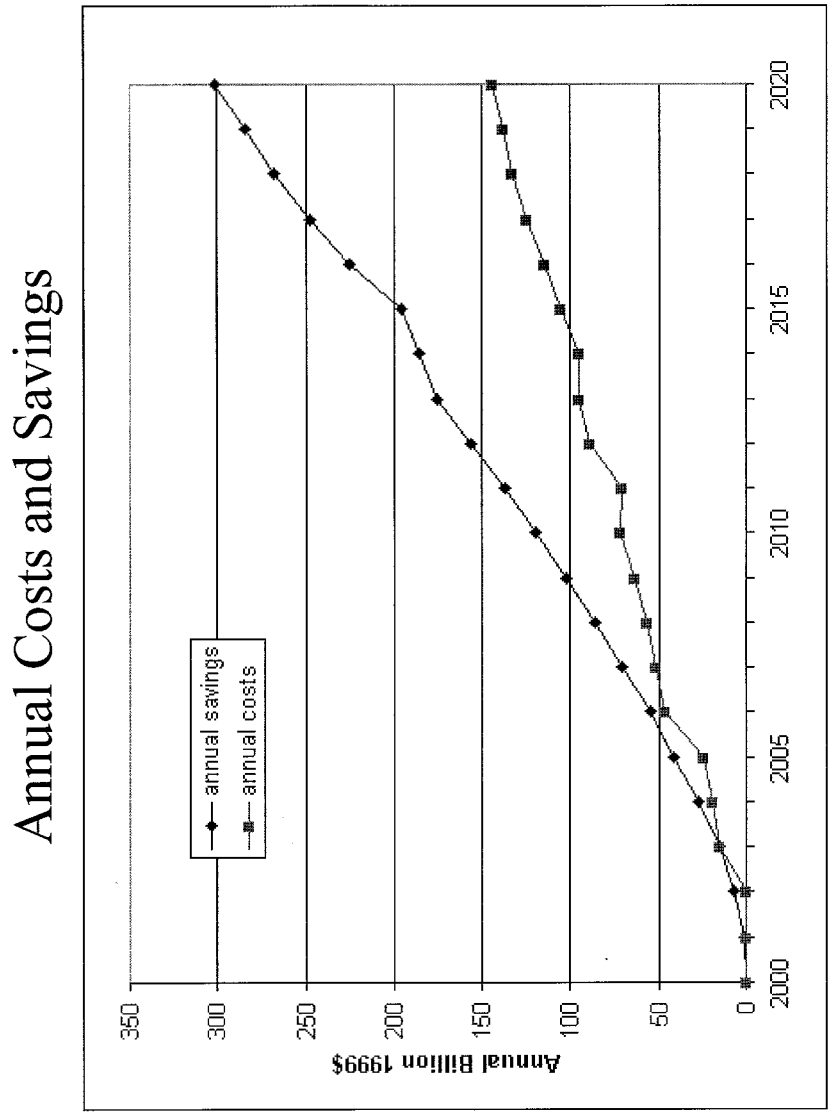


Residential Energy Bill

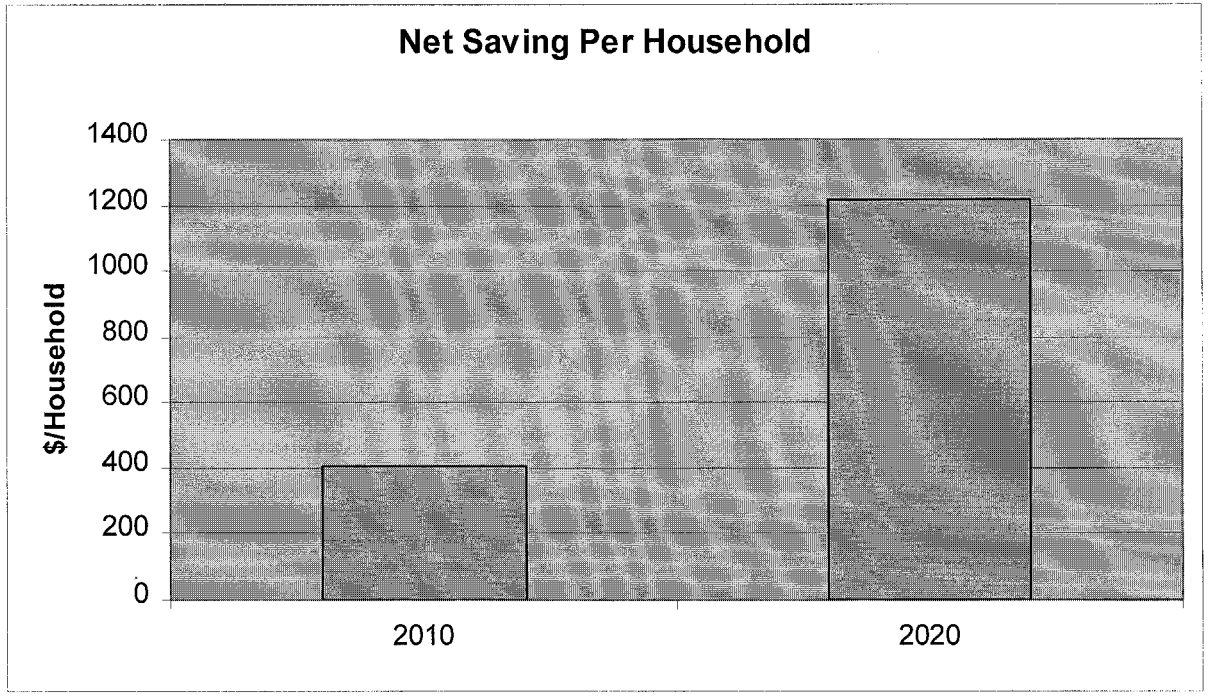


Cost of Saved Carbon

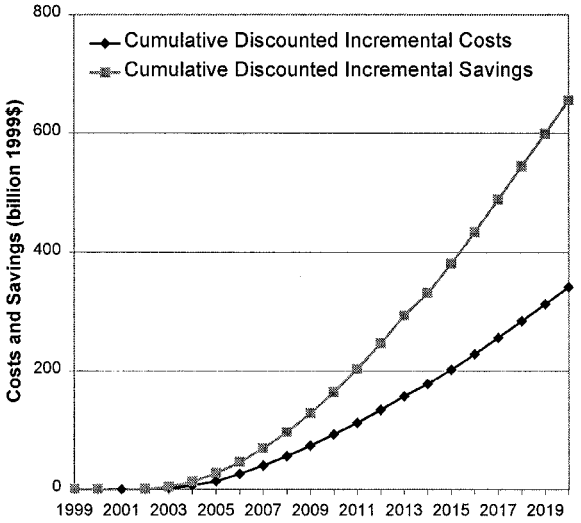
		2020	
	annual carbon reduction	Cumulative PV Net Costs	Cost of saved carbon
	MtC	billions 1999$	1999$ / tC
Buildings and industry subtotal	**509**	**-$533**	**-$242**
Transportation subtotal	**255**	**-$286**	**-$265**
Electricity subtotal	**190**	**$258**	**$188**
RPS (estimate)	81	-$8	-$19
TOTAL	**954**	**-$561**	**-$121**


Annual Costs and Savings
annual savings
annual costs
Annual Billion 1999$
350
300
250
200
150
100
50
0
2000
2005
2010
2015
2020

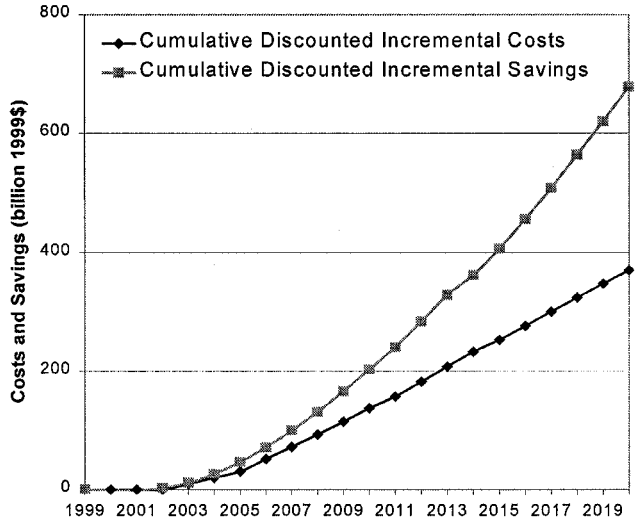
Annual Net Savings



Cumulative Costs and Benefits – Households (billion $)



Cumulative Costs and Benefits–Business, Industry (billion $)



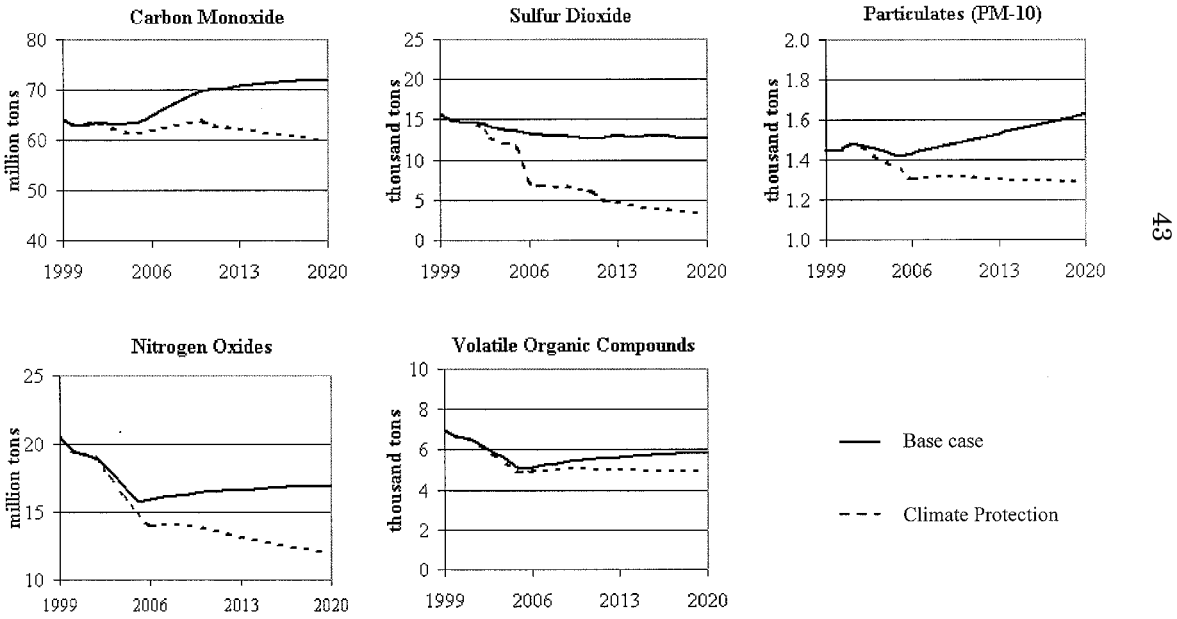
Macroeconomic Impacts of Policy Scenario by Sector, 2020

	Net Change in Jobs	Net Change in Wage and Salary Compensation (Million1998$)	Net Change in GDP (Million1998$)
Agriculture	63,100	$620	$2,120
Other Mining	11,200	$870	$1,830
Coal Mining	(23,900)	($2,340)	($4,940)
Oil/Gas Mining	(61,400)	($5,210)	($20,600)
Construction	340,300	$10,460	$15,030
Food Processing	16,100	$750	$1,380
Other Manufacturing	77,900	$9,360	$14,160
Pulp and Paper Mills	5,000	$570	$950
Oil Refining	(6,300)	($650)	($1,910)
Stone, Glass, and Clay	24,800	$1,630	$2,750
Primary Metals	18,600	$2,190	$3,180
Metal Durables	42,000	$4,670	$7,670
Motor Vehicles	54,300	$5,090	$8,350
Transportation, Communication, and Utilities	50,500	$3,320	$6,750
Electric Utilities	(35,100)	($5,180)	($27,540)
Natural Gas Utilities	(26,200)	($3,080)	($11,180)
Wholesale Trade	12,400	$1,030	$1,890
Retail Trade	190,300	$4,410	$7,680
Finance	42,100	$4,570	$9,410
Insurance/Real Estate	11,900	$350	$2,420
Services	394,600	$13,080	$18,460
Education	33,200	$1,330	$1,340
Government	78,900	$3,550	$4,660
Total	**1,314,300**	**$51,390**	**$43,860**

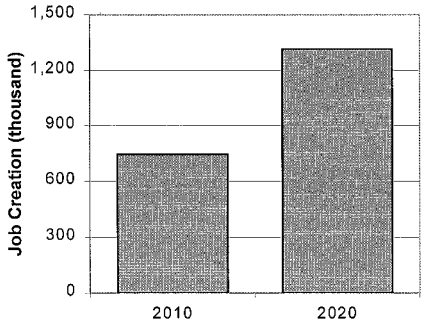
Job Impacts by State

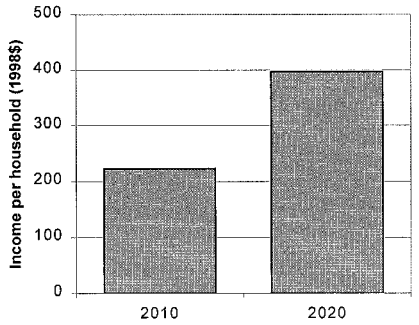
State	Net Job Gain 2010	Net Job Gain 2020
01 Alabama	13,100	22,600
02 Alaska	2,800	5,000
04 Arizona	11,200	19,900
05 Arkansas	7,500	13,200
06 California	77,400	141,400
08 Colorado	10,000	17,700
09 Connecticut	7,800	14,100
10 Delaware	2,200	3,800
11 District of Columbia	1,600	3,500
12 Florida	37,000	66,800
13 Georgia	21,300	38,300
15 Hawaii	2,700	5,000
16 Idaho	3,500	6,200
17 Illinois	31,900	56,400
18 Indiana	20,900	36,000
19 Iowa	8,300	14,700
20 Kansas	7,100	12,500
21 Kentucky	11,500	19,300
22 Louisiana	19,200	32,900
23 Maine	3,700	6,600
24 Maryland	12,500	22,000
25 Massachusetts	14,500	26,700
26 Michigan	29,800	51,000
27 Minnesota	13,400	24,000
28 Mississippi	7,200	12,600
29 Missouri	15,100	26,600
30 Montana	2,300	4,000
31 Nebraska	4,700	8,500
32 Nevada	5,300	9,100
33 New Hampshire	2,800	5,000
34 New Jersey	20,200	36,200
35 New Mexico	4,200	7,100
36 New York	38,000	68,200
37 North Carolina	22,400	38,900
38 North Dakota	1,900	3,300
39 Ohio	34,600	59,900
40 Oklahoma	8,200	13,700
41 Oregon	8,600	15,600
42 Pennsylvania	31,600	55,500
44 Rhode Island	2,100	3,900
45 South Carolina	11,500	20,000
46 South Dakota	2,000	3,500
47 Tennessee	17,100	29,800
48 Texas	71,500	123,400
49 Utah	5,700	10,300
50 Vermont	1,600	2,800
51 Virginia	18,500	32,100
53 Washington	16,600	29,700
54 West Virginia	3,800	6,000
55 Wisconsin	14,900	26,300
56 Wyoming	1,700	2,600
Total	**744,900**	**1,314,300**

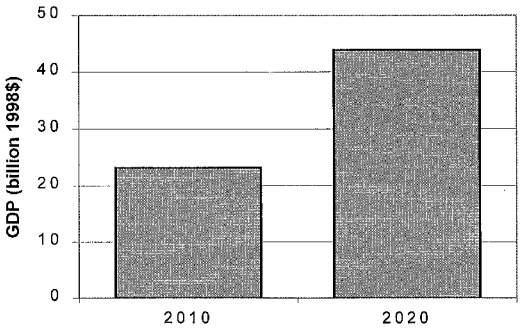
Local Air Pollutant Reductions



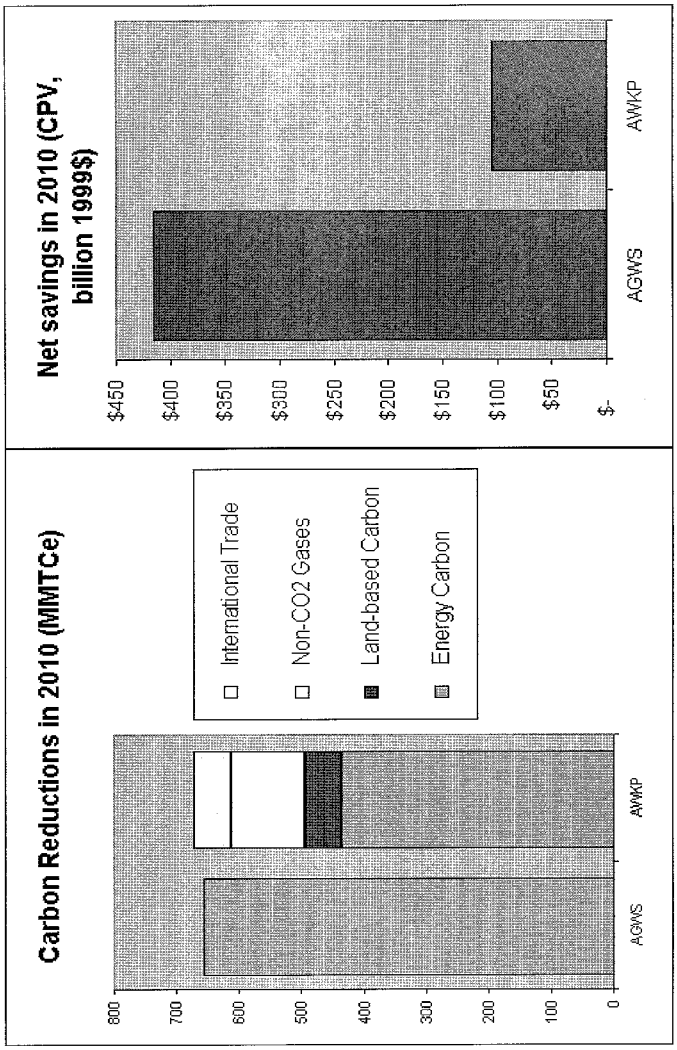
Macroeconomic Impacts







Impact of Delay



Results

	1990	2010 Base Case	2010 Climate Protection	2020 Base Case	2020 Climate Protection
End-use Energy (Quads)	63.9	86.0	76.4	97.2	72.6
Primary Energy (Quads)	84.6	114.1	101.2	127.0	89.4
Renewable Energy (Quads)					
Non-Hydro	3.5	5.0	10.4	5.5	11.0
Hydro	3.0	3.1	3.1	3.1	3.1
Net GHG Emissions (MtCe)	1,648	2,204	1,533	------	------
Energy Carbon	1,338	1,808	1,372	2,042	1,087
Land-based Carbon	------	------	-58	------	------
Non-CO2 Gases	310	397	279	------	------
International Trade	------	------	-60	------	------
Net Savings					
Cumulative present value (billion$)	------	------	$102	------	$561
Levelized annual (billion$/year)	------	------	$13	------	$49
Levelized annual per household ($/year)	------	------	$113	------	$375

Carbon Abatement With Economic Growth: A National Strategy

Stephen Bernow, Alison Bailie,
William Dougherty, Sivan Kartha
and Michael Lazarus

Tellus Institute

with
Marshall Goldberg
MRG&Associates

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1. Introduction and Summary

The risk of catastrophic global climate disruption from human activities could be mitigated if atmospheric CO_2 concentrations are stabilized at approximately 450 parts per million, about 60 percent above pre-industrial concentrations. This requires keeping total global carbon emissions within 500 billion tons over the 21st century, rather than the 1,400 billion tons towards which the world is now headed. Achieving this goal would require that annual global carbon emissions from fossil fuels be at least halved from its current 6 million tons instead of tripled by the end of the century, and that deforestation is halted. This requires that global annual per-capita carbon emissions decrease from today's 1 ton to less than 0.3 tons, whereas with business-as-usual per-capita emissions will grow to almost 2 tons, notwithstanding growing populations and economies. For U.S., which currently emits about one-fourth of the global total at almost 6 tons per-capita, this implies a twenty-fold decrease in carbon intensity and more than ten-fold decrease in emissions over the century, if national emissions converged during the century to equal per-capita limits under a global climate stabilization path. Whatever burden sharing approach is adopted, it is clear that the U.S. will have to radically reduce its carbon emissions over the next several decades.

This paper presents the results of a study showing that the U.S. could dramatically reduce its greenhouse gas emissions over the next two decades while the economy continues to grow.[1] It examines a set of policies to increase energy efficiency, accelerate adoption of renewable energy, reduce air pollution, and shift to less carbon-intensive fuels. The policies are targeted within and across sectors – residential and commercial buildings, industrial facilities, transportation, and power generation. They include incentives, standards, codes, market mechanisms, regulatory reform, research and development, public outreach, technical assistance and infrastructure investment.

Together with steps to reduce emissions of non-CO_2 greenhouse gases and land-based CO_2 emissions, and the acquisition of a limited amount of allowances internationally, this portfolio of policies would allow the U.S. to meet its obligations under the Kyoto Protocol, reducing its GHG emissions to 7 percent below 1990 levels by 2010, with far greater reductions by 2012. It would bring overall economic *benefits* to the US, since lower fuel and electricity bills would more than pay the costs of technology innovation and program implementation. In 2010, the annual savings would exceed costs by $50 billion, and by 2020 by approximately $135 billion. At the same time, jobs, GDP and incomes would increase, and pollutant emissions would decrease.

Energy use in buildings, industries, transportation, and electricity generation was modeled for this study using the U.S. Department of Energy, Energy Information Administration's National Energy Modeling System (NEMS). The NEMS model version, data and assumptions employed in this study were those of EIA's (Energy Info Admin.) *Annual Energy Outlook*[2], which also formed the basis for the Base Case. We refined the NEMS model with advice from EIA, based on their ongoing model improvements, and drawing on expertise from colleagues at Union of Concerned Scientists, the National Laboratories and elsewhere.

Table 1 provides summary results on overall energy and greenhouse gas impacts and economic impacts of the policy set for the *Base Case* and *Climate Protection Case* for 2010 and 2020. The policies cause reductions in primary energy consumption that reach 11 percent by 2010 and 30 percent in 2020, relative to the Base Case in those years, through increased efficiency and greater adoption of cogeneration of heat and power (CHP).

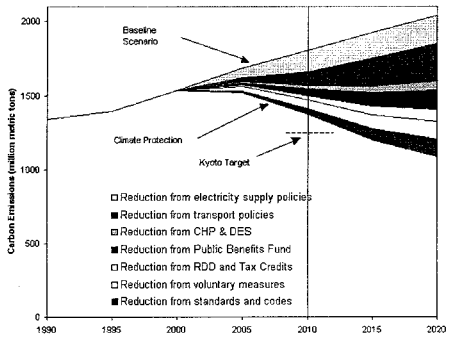
Table 1: Summary of Results

	1990[3]	2010 Base Case	2010 Climate Protection	2020 Base Case	2020 Climate Protection
End-use Energy (Quads)	63.9	86.0	76.4	97.2	72.6
Primary Energy (Quads)	84.6	114.1	101.2	127.0	89.4
Renewable Energy (Quads)					
Non-Hydro	3.5	5.0	10.4	5.5	11.0
Hydro	3.0	3.1	3.1	3.1	3.1
Net GHG Emissions (MtCe/yr)	1,648	2,204	1,533	-----	-----
Energy Carbon	1,338	1,808	1,372	2,042	1,087
Land-based Carbon	-----	-----	-58	-----	-----
Non-CO_2 Gases	310	397	279	-----	-----
International Trade	-----	-----	-60	-----	-----
Net Savings[4]					
Cumulative present value (billion$)	------	------	$105	------	$576
Levelized annual (billion$/year)	------	------	$13	------	$49
Levelized annual per household ($/year)	------	------	$113	------	$375
Macro-economic Impacts (Changes in Year)[5]					
GDP (billions$)	-----	-----	23.2	-----	43.9
Jobs	-----	-----	0.7	-----	1.3
Wages/Compensation($household)	-----	-----	220	-----	400

Relative to today's levels, use of non-hydro renewable energy roughly triples by 2010 in the Climate Protection Case, owing to a Renewable Portfolio Standard (RPS), whereas in the Base Case it increases by less than 50 percent. Given the entire set of policies, non-hydro renewable energy doubles relative to the Base Case in 2010, accounting for about 10 percent of total primary energy supplies. The absolute amount of renewables does not increase substantially between 2010 and 2020 because the 10 % RPS electric sector targets in 2010 give the same absolute amount as the 20% in 2020 since demand declines sharply owing to the efficiency policies. A more aggressive renewables policy for the 2010-2020 period could be considered.[6]

The reductions in energy-related carbon emissions are even more dramatic than the reductions in energy consumption, because of the shift toward lower-carbon fuels and renewable energy. Carbon emissions have already risen by over 15 percent since 1990, and in the Base Case will rise a total of 35 percent by 2010, in stark contrast to the 7 percent emissions *reduction* that the U.S. negotiated at Kyoto. In the Climate Protection case, the U.S. promptly begins to reduce energy-related carbon emissions, and by 2010 emissions are only 2.5 percent above 1990 levels, and by 2020, emissions are well below 1990 levels. Relative to the Base case, the 2010 reductions[7] amount to 436 MtC/yr.

Figure 1: Reductions in Energy-related Carbon Emissions, Displayed by Major Policy Group



Land-based activities, such as forestry, land-use, and agriculture, yield another 58 MtC/yr of reductions. Methane emissions are also reduced, through measures aimed at landfills, natural gas production and distribution systems, mines, and livestock husbandry. The potent fluorine-containing greenhouse gases are reduced by substituting with non-greenhouse gases, implementing alternative cleaning processes in the semiconductor industry, reducing leaks, and investing in more efficient gas-using equipment. In total, the Climate Protection case adopts reductions of these other greenhouse gases equivalent to 118 MtC/yr by 2010.

Together the reduction measures for energy-related carbon (436 MtC/yr), land-based carbon (58 MtC/yr), and non-carbon gases (118 MtCe/yr) amount to 612 MtCe/yr of reductions in 2010. Through these measures, the U.S. is able to accomplish the vast majority of its emissions reduction obligation under the Kyoto Protocol through domestic actions. This leaves the United States slightly shy of its Kyoto target, with only 60 MtC/yr worth of emissions allowances to procure from other countries though the "flexibility mechanisms" of the Kyoto Protocol – (Emissions Trading, Joint Implementation, and the Clean Development Mechanism). The Climate Protection case assumes that the U.S. will take steps to ensure that allowances procured through these flexibility mechanisms reflect legitimate mitigation activity. In particular, we assume that U.S. restrains its use of so-called "hot air" allowances, i.e., allowances sold by countries that negotiated excessively high Kyoto targets.

The set of policies in the *Climate Protection* Case also reduces criteria air pollutants that cause or aggravate human health problems, and adversely affect agriculture, forests, water resources, and buildings. The policies would significantly reduce energy-related emissions as summarized in Table 2. Sulfur oxide emissions would decrease the most – by half in 2010 and by nearly 75 percent in 2020. The other pollutants are reduced between 7 and 16 percent by 2010, and between 17 and 29 percent by 2020, relative to *Base* case levels in those years.

Table 2: Impact of Policies on Air Pollutant Emissions

	1900	2010 Base Case	2010 Climate Protection	2020 Base Case	2020 Climate Protection
CO	65.1	69.8	63.8	71.8	59.8
NOx	21.9	16.5	13.9	16.9	12.0
SO2	19.3	12.8	6.2	12.7	3.3
VOC	7.7	5.5	5.1	5.9	4.9
PM-10	1.7	1.5	1.3	1.6	1.3

The complete Climate Protection package provides net economic benefits to the U.S., while improving public health and the environment. In dramatically reducing energy consumption, the Climate Protection strategy reduces our dependence on insecure energy supplies and positions the U.S. as a supplier of innovative and environmentally superior technologies and practices.

Far from being the economically crippling burden that some allege and others fear, ratifying the Kyoto Protocol and ambitiously reducing greenhouse gas emissions could initiate a national technological and economic renaissance with cleaner energy, industrial processes and products in the coming decades. In the U.S, we therefore face an important challenge. We can be followers, leaving other more forward-looking countries to assume the global leadership in charting a sustainable path. Or we can embrace the opportunity to usher in a technological and environmental transition, providing world markets with the advanced and clean energy technologies needed to sustain the new century's economic growth.

2. Energy Policies

Analyses of the investment costs and energy savings of policies to promote energy efficiency and co-generation in the residential, commercial, and industrial sectors and efficiency for light duty vehicles, were taken primarily from the American Council for an Energy Efficient Economy.[8] Analyses of avoided energy, costs and emissions, pollutant emissions caps, renewable energy, and other transportation modes followed the approaches taken in Bernow *et al.*[9] Below we group these policies into the particular sector where they take effect, and describe the key assumptions made concerning the technological impacts of the individual policies. Unless otherwise indicated, each of the policies is assumed to start in 2003.

In evaluating the avoided energy, costs and emissions of these policies we relied primarily on the U.S. Department of Energy's NEMS model, data and assumptions. We adapted the Energy Information Administration's 2001 Reference Case Forecast[10] to create a slightly revised "Base Case." Our policies build on those included in this Base Case forecast (i.e., we avoid taking credit for emissions reductions, costs, or savings already included in the EIA 2001 Reference Case).

2.1 Policies in the Buildings and Industrial Sectors

Carbon emissions from fuel combustion in residential and commercial buildings account for about 10 percent of U.S. greenhouse gas emissions, while emissions from the industrial sector account for another 20 percent. When emissions associated with the electricity consumed are counted, these levels reach over 35 percent for buildings and 30 percent for industry. We analyzed a set of policies that include new building codes, new appliance standards, tax incentives for the purchase of high efficiency products, a national public benefits fund, expanded research and development, voluntary agreements and support for combined heat and power.

Building codes

Building energy codes require all new residential and commercial buildings to be built to a minimum level of energy efficiency that is cost-effective and technically feasible. "Good practice" residential energy codes, defined as the 1992 (or a more recent) version of the Model Energy Code (now known as the International Energy Conservation Code), have been adopted by 32 states.[11] "Good practice" commercial energy codes, defined as the ASHRAE 90.1 model standard, have been adopted by 29 states.[12] However, the Energy Policy Act of 1992 (EPAct) requires all states to adopt a commercial building code that meets or exceeds ASHRAE 90.1, and requires all states to consider upgrading their residential code to meet or exceed the 1992 Model Energy Code.

This policy assumes that DOE enforces the commercial building code requirement in EPAct and that states comply. We also assume that relevant states upgrade their residential energy code to either the 1995 or 1998 Model Energy Code either voluntarily or through the adoption of a new federal requirement. Furthermore, we assume that the model energy codes are significantly improved during the next decade and that all states adopt mandatory codes that go beyond current "good practice" by 2010. To quantify the impact of these changes, we assume a 20 percent energy savings in heating and cooling in buildings in half of new homes and commercial buildings.

New Appliance and Equipment Efficiency Standards

The track record for electricity efficiency standards is impressive, starting with the National Appliance Energy Conservation Act of 1987 and continuing through the various updates that were enacted in early 2001 for washers, water heaters, and central air conditioners. These standards have removed the most inefficient models from the market, while still leaving consumers with a diversity of products. An analysis of Department of Energy figures by the American Council for an Energy Efficient Economy, estimates nearly 8 percent of annual electricity consumption will be saved in 2020 due to standards already enacted[13]. However, many appliance efficiency standards haven't kept pace with either legal update requirements or technological advances. The Department of Energy is many years behind its legal obligation to regularly upgrade standards for certain appliances to the "maximum level of energy efficiency that is technically feasible and economically justified."

In this study, we assume that the government upgrades existing standards or introduces new standards for several key appliances and equipment types: distribution transformers, commercial air conditioning systems, residential heating systems, commercial refrigerators, exit signs, traffic lights, *torchiere* lighting fixtures, ice makers, and standby power consumption for consumer electronics. We also assume the higher energy efficiency standards for residential central air

conditioning and heat pumps than was allowed by the Bush Administration. These are all measures that can be taken in the near term, based on technologies that are available and cost-effective.

Tax Incentives

A wide range of advanced energy-efficient products have been proven and commercialized, but have not yet become firmly established in the marketplace. A major reason for this is that conventional technologies get "locked-in"; they benefit from economies of scale, consumer awareness and familiarity, and already existing infrastructure that make them more able to attract consumers, while alternatives are overlooked though they could be financially viable once mass-produced and widely demonstrated.

In this study, we include initial tax incentives for a number of products. For consumer appliances, we considered a tax incentive of $50 to $100 per unit. For new homes that are at least 30 percent more efficient that the Model Energy Code, we considered an incentive of up to $2,000 per home; for commercial buildings with at least 50 percent reduction in heating and cooling costs relative to applicable building codes, we applied an incentive equal to $2.25 per square foot. Regarding building equipment such as efficient furnaces, fuel cell power systems, gas-fired heat pumps, and electric heat pump water heaters, we considered a 20 percent investment tax credit. Each of these incentives would be introduced with a sunset clause, terminating them or phasing them out in approximately five years, so as to avoid their becoming permanent subsidies. Versions of all of the tax incentives considered here have already been introduced into bills before the Senate and/or House[14].

National Public Benefits Fund

Electric utilities have historically funded programs to encourage more efficient energy-using equipment, assist low-income families with home weatherization, commercialize renewables, and undertake research and development (R&D). Such programs have typically achieved electricity bill savings for households and businesses that are roughly twice the program costs [15]. Despite the proven effectiveness of such technologies and programs, increasing price competition and restructuring have caused utilities to reduce these "public benefit" expenditures over the past several years. In order to preserve such programs, fifteen states have instituted public benefits funds that are financed by a small surcharge on all power delivered to consumers.

This study's policy package includes a national level public benefits fund (PBF) fashioned after the proposal introduced by Sen. Jeffords (S. 1369) and Rep. Pallone (H. 2569) in the 106th Congress. The PBF would levy a surcharge of 0.2 cents per kilowatt-hour on all electricity sold, costing the typical residential consumer about $1 per month. This federal fund would provide matching funds for states for approved public benefits expenditures. In this study, the PBF is allocated to several different programs directed at improvements in lighting, air conditioning, motors, and other cost-effective energy efficiency improvements in electricity-using equipment.

Expand Federal Funding for Research and Development in Energy Efficient Technologies

Federal R&D funding for energy efficiency has been a spectacularly cost-effective investment. The DOE has estimated that the energy savings from 20 of its energy efficiency R&D programs has been roughly $30 billion so far – more than three times the federal appropriation for the entire energy efficiency and renewables R&D budget throughout the 1990s.[16]

Tremendous opportunities exist for further progress in material-processing technologies, manufacturing processing, electric motors, windows, building shells, lighting, heating/cooling systems, and super-insulation, for example. The EPA's *Energy Star* programs have also saved large amounts of energy, building on the achievements of R&D efforts and ushering efficient products into the marketplace. By certifying and labeling efficient lighting, office equipment, homes and offices, *Energy Star* has helped foster a market transformation toward much more efficient products and buildings. Currently, roughly 80 percent of personal computers, 95 percent of monitors, 99 percent of printers, and 65 percent of copiers sold are Energy Star certified.[17] In light of these successes, EPA should be allocated the funds to broaden the scope of its Energy Star program, expanding to other products (refrigerators, motors) and building sectors (hotels, retailers), and the vast market of existing buildings that could be retrofitted. In this study, we assume that increased funding to expand research and development efforts in industry (e.g., motors) buildings (e.g., advanced heating/cooling), and transport (e.g., more fuel efficient cars and trucks) will lead to more energy-savings products becoming commercially available.

Support for Co-generation

Cogeneration (or, combined heat and power – CHP) is a super-efficient means of co-producing two energy-intensive products that are usually produced separately – heat and power. The technical and economical value of CHP has been widely demonstrated, and some European countries rely heavily on CHP for producing power and providing heat to industries, businesses, and households. The thermal energy produced in co-generation can also be used for (building and process) cooling or to provide mechanical power.

While CHP already provides about 9 percent of all electricity in the US, there are considerable barriers to its wider cost-effective implementation[18]. Environmental standards should be refined to recognize the greater overall efficiency of CHP systems, for example by assessing facility emissions on the basis of fuel input, rather than useful energy output. Non-uniform tax standards discourage CHP implementation in certain facilities. Moreover, utility practices are generally highly hostile to prospective CHP operators, through discriminatory pricing and burdensome technical requirements and costs for connecting to the grid.

In this study, we include policies that would establish a standard permitting process, uniform tax treatment, accurate environmental standards, and fair access to electricity consumers through the grid. Such measures would help to unleash a significant portion of the enormous potential for CHP. In this study we assumed 50 GW of new CHP capacity by 2010, and an additional 95 GW between 2011 and 2020. With electricity demand reduced by the various energy efficiency policies adopted in this study, co-generated electricity reaches 8 percent of total remaining electricity requirements in 2010 and 36 percent in 2020.

2.2 Policies in the Electric Sector

A major goal for U.S. energy and climate policy is to dramatically reduce carbon and other pollutant emissions from the electric sector, which is responsible for more than one-third of all U.S. greenhouse gas emissions. We analyzed a set of policies in the electric sector that include standards and mechanisms to help overcome existing market barriers to investments in technologies that can reduce emissions. The three policies -- a renewable portfolio standard, a cap on pollutant emissions, and a carbon cap and trade system -- are described below.

Renewable Portfolio Standard

A Renewable Portfolio Standard (RPS) is a flexible, market-oriented policy for accelerating the introduction of renewable resources and technologies into the electric sector. An RPS sets a schedule for establishing a minimum amount of renewable electricity as a fraction of total generation, and requires each generator that sells electricity to meet the minimum either by producing that amount of renewable electricity in its mix or acquiring credits from generators that exceed the minimum. The market determines the portfolio of technologies and geographic distribution of facilities that meet the target at least cost. This is achieved by a trading system that awards credits to generators for producing renewable electricity and allows them to sell or purchase these credits. Thirteen states – Arizona, Connecticut, Hawaii, Iowa, Maine, Massachusetts, Minnesota, Nevada, New Jersey, New Mexico, Pennsylvania, Texas, and Wisconsin – already have RPSs, and Senator Jeffords introduced a bill in the 106th Congress (S. 1369) to establish a national RPS.

In this study, we have applied an RPS that starts at a 2 percent requirement in 2002, grows to 10 percent in 2010, and to 20 percent in 2020, after all efficiency policies are included. Wind, solar, geothermal, biomass, and landfill gas are eligible renewable sources of electricity, but environmental concerns exclude municipal solid waste (owing to concerns about toxic emissions from waste-burning plants) and large-scale hydro (which, in any event, need not be treated as an emerging energy technology as it already supplies nearly 10 percent of the nation's electricity supply).

We also here tighten the existing SO_2 cap so as to reduce sulfur emissions to roughly 40 percent of current levels by 2010 and one third of current levels by 2020. We also impose a cap-and-trade system on NO_x emissions in the summertime, when NO_x contributes more severely to photochemical smog. This system expands the current cap and trade program, which calls on 19 states to meet a target in 2003 that then remains constant, to include all states with a cap that is set first in 2003 but decreases in 2010, relative to 1999 levels. The cap results in a 25 percent reduction of annual NO_x emissions by 2003, and a 50 percent reduction by 2010.

Carbon Cap-And-Trade Permit System

This study introduces a cap-and-trade system for carbon in the electric sector; with the cap set to achieve progressively more stringent targets over time, starting in 2003 at 2 percent below current levels, increasing to 12 percent below current by 2010 and 30 percent below by 2020. Restricting carbon emissions from electricity generation has important co-benefits, including reduced emissions of SO_2 and NO_x, as discussed above, fine particulate matter, which is a known cause of respiratory ailments, and mercury, which is a powerful nervous system toxin and already contaminates over 50,000 lakes and streams in the US. A progressively more stringent target also reduces demand for coal, and hence mining-related pollution of streams and degradation of landscapes and terrestrial habitats.

In the SO_2, NO_x, and CO_2 trading systems, permits are distributed through an open auction, and the resulting revenues can be returned to households (e.g., through a tax reduction or as a rebate back to households). Recent analyses suggest that an auction is the most economically efficient way to distribute permits, meeting emissions caps at lower cost than allocations based on grandfather allowances or equal per kWh allowances[19]. Implementing such auctions for the electric sector will also clear the way for an economy-wide approach in future years based on

auctioning. In this study, the price of auctioned carbon permits reaches $100 per metric ton carbon.

While not specifically targeted by the trading programs, the operators of the 850 old "grand-fathered" coal plants built before the Clean Air Act of 1970, which emit 3-5 times as much pollution per unit of power generated than newer coal power plants, will likely retire these plants rather than face the cost of purchase the large amount of credits necessary to keep them running. When the Clean Air Act was adopted, it was expected that these dirty power plants would eventually be retired. However, utilities are continuing to operate these plants beyond their design life, and have in fact increased their output over the last decade. By subjecting these old plants to the same requirements as newer facilities, as has been done or is being considered in several states including Massachusetts and Texas, operators would be obliged to modernize the old plants or to retire them in favor of cleaner electric generation alternatives.

2.3 Policies in the Transport Sector

Another goal for U.S. energy and climate policy is to reduce carbon emissions from the transport sector, which is responsible for about one-third of all U.S. greenhouse gas emissions. We analyzed a set of policies in the transportation sector that include improved efficiency (light duty vehicles, heavy duty trucks and aircraft), a full fuel-cycle GHG standard for motor fuels, measures to reduce road travel, and high-speed rail (HSR).

Strengthened CAFE Standards

Today's cars are governed by fuel economy standards that were set in the mid-1970s. The efficiency gains made in meeting those standards have been entirely wiped out by increases in population and driving, as well as the trend toward gas-guzzling SUVs. When the fuel economy standards were implemented, light duty trucks only accounted for about 20 percent of vehicle sales. Light trucks now account for nearly 50 percent of new vehicle sales; this has brought down the overall fuel economy of the light duty vehicle fleet, which now stands at its lowest average fuel economy since 1981. If the fuel economy of new vehicles had held at 1981 levels rather than tipping downward, American vehicle owners would be importing half a million fewer barrels of oil each day.

We introduce in this study a strengthened Corporate Average Fuel Economy (CAFE) standard for cars and light trucks, along with complementary market incentive programs. Specifically, fuel economy standards for new cars and light trucks rise from EIA's projected 25.2 mpg for 2001 to 36.5 mpg in 2010, continuing to 50.5 mpg by 2020. This increase in vehicle fuel economy would save by 2020 approximately twice as much oil as could be pumped from Arctic National Wildlife Refuge oil field over its entire 50-year lifespan[20]. Based on assessments of near-term technologies for conventional vehicles, and advanced vehicle technologies for the longer-term, we estimate that the 2010 CAFE target can be met with an incremental vehicle cost of approximately $855, and the 2020 CAFE target with an incremental cost of $1,900. To put these incremental costs in perspective, they are two to three times less than the fuel savings at the gasoline pump over the vehicle's lifetime[21].

Improving Efficiency of Freight Transport

We also consider policies to improve fuel economy for heavy-duty truck freight transport, which accounts for approximately 16 percent of all transport energy consumption. A variety of improvements such as advanced diesel engines, drag reduction, rolling resistance, load reduction strategies, and low friction drivetrains offer opportunities to increase the fuel economy of freight trucks.

To accelerate the improvement in heavy duty truck efficiency, we have considered measures that expand R&D for heavy duty diesel technology, vehicle labeling and promotion, financial incentives to stimulate the introduction of new technologies, efficiency standards for medium- and heavy-duty trucks, and fuel taxes and user-fees calibrated to eliminate the existing subsidies for freight trucking. Together, it is estimated that these policies could bring about a fuel economy improvement of 6 percent by 2010, and 23 percent by 2020, relative to today's trucks.

Improving Efficiency of Air Travel

Air travel is the quickest growing mode of travel, and far more energy intensive than vehicle travel. One passenger mile of air travel today requires about 1.7 times as much fuel as vehicle travel.[22] We consider here policies for improving the efficiency of air travel, including R&D in efficient aircraft technologies, fuel consumption standards, and a revamping of policies that subsidize air travel through public investments.

We assume that air travel efficiency improves by 23 percent by 2010, and 53 percent by 2020. This is in contrast to the Base Case where efficiency increases by 9 percent by 2010 and 15 percent by 2020, owing to a combination of aircraft efficiency improvements (advanced engine types, lightweight composite materials, and advanced aerodynamics), increased load factor, and acceleration of air traffic management improvements[23]. We assume that air travel can reach 82 seat-miles per gallon by 2020 from its current 51.

Greenhouse Gas Standards for Motor Fuels

Transportation in the U.S. relies overwhelmingly on petroleum-based fuels, making it a major source of GHG emissions. We introduce here a full fuel-cycle GHG standard for motor fuels, similar in concept to the RPS for the electric sector. The standard is a cap on the average GHG emissions from gasoline, and would be made progressively more stringent over time. Fuel suppliers would have the flexibility to meet the standard on their own or by buying tradable credits from other producers of renewable or low-GHG fuel.

The policy adopted in this study requires a 3 percent reduction in the average national GHG emission factor of fuels used in light duty vehicles in 2010, increasing to a 7 percent reduction by 2020. The policy would be complemented by expanded R&D, market creation programs, and financial incentives. Such a program would stimulate the production of low-GHG fuels such as cellulosic ethanol and biomass- or solar-based hydrogen.

For this modeling study, we assume that most of the low-GHG fuel is provided as cellulosic ethanol, which can be produced from agricultural residues, forest and mill wastes, urban wood wastes, and short rotation woody crops[24]. As cellulosic ethanol can be co-produced along with electricity, in this study we assume that electricity output reaches 10 percent of ethanol output by 2010 and 40 percent by 2020[25]. Due to the accelerated development of the production technology

for cellulosic ethanol, we estimate that the price falls to $1.4 per gallon of gasoline equivalent by 2010 and remains at that price thereafter[26].

Improving Alternative Modes to Reduce Vehicle Miles Traveled

The amount of travel in cars and light duty trucks continues to grow due to increasing population and low vehicle occupancy. Between 1999 and 2020, the rate of growth in vehicle miles traveled is projected to increase in the Base Case by about 2 percent per year. The overall efficiency of the passenger transportation system can be significantly improved through measures that contain the growth in vehicle miles traveled through land-use and infrastructure investments and pricing reforms to remove implicit subsidies for cars, which are very energy intensive.

We assume that these measures will primarily affect urban passenger transportation and result in a shift to higher occupancy vehicles, including carpooling, vanpooling, public transportation, and telecommuting. We consider that the level of reductions of vehicle miles traveled that can be achieved by these measures relative to the Base Case are 8 percent by 2010 and 11 percent by 2020.

High-Speed Rail

High-speed rail (HSR) offers an attractive alternative to intercity vehicle travel and short distance air travel. In both energy cost and travel time, high-speed rail may be competitive with air travel for trips of roughly 600 miles or less, which account for about one-third of domestic air passenger miles traveled. Investments in rail facilities for key inter-city routes (such as the Northeast corridor between Washington and Boston, the East cost of Florida between Miami and Tampa, and the route linking Los Angeles and San Francisco) could provide an acceptable alternative and reduce air travel in some of the busiest flight corridors[27].

In this analysis we have taken the DOT's recent estimates of the potential high-speed rail ridership which, based on projected mode shifts from air and automobile travel in several major corridors of the US, reaches about 2 billion passenger miles by 2020[28]. While this level of HRS ridership provides relatively small energy and carbon benefits by 2020, it can be viewed as the first phase of a longer-term transition to far greater ridership and more advanced, faster and efficient electric and MAGLEV systems in the ensuing decades.

2.4 Summary Results

Table 3 summarizes the carbon reductions and the net costs (generally net benefits) of each energy policy through 2010 and 2020. Carbon reductions reach 436 MtC in 2010 (about 24 percent below the Base Case in that year) and 954 MtC in 2020 (about 47 percent below the Base Case in that year). The costs were computed by discounting and summing the incremental annualized capital costs, administrative costs, incremental O&M and fuel costs, and subtracting the discounted O&M and fuel cost savings, using a 5 percent real discount rate. Overall the net savings achieved by the demand policies more than offset the net costs for the electric supply policies. The Climate Protection policy package as a whole results in cumulative net savings of $80/tC through 2010, and $121/tC through 2020.[29]

Table 3. Carbon reductions, net costs, and cost per saved carbon in 2010 and 2020

	2010			2020		
	Carbon Savings MtC/yr	Cumulative Net Cost (present value) billion (1999)$	Cost of saved carbon (1999)$ per tC	Carbon Savings MtC/yr	Cumulative Net Cost (present value) billion (1999)$	Cost of saved carbon (1999)$ per tC
Buildings & Industry Sectors						
Appliance standards	29	-$24	-$315	86	-$84	-$256
Building Codes	7	-$5	-$353	30	-$23	-$244
Voluntary measures	61	-$50	-$229	118	-$112	-$179
Research and design	21	-$18	-$257	71	-$53	-$186
Public Benefits Fund	50	-$29	-$224	134	-$101	-$187
Tax Credits	4	-$4	-$292	11	-$8	-$152
CHP and DES	21	-$53	-$611	59	-$151	-$554
subtotal	**193**	**-$183**	**-$301**	**509**	**-$533**	**-$242**
Electric Sector						
RPS; NOx/Sox Cap and Trade; Carbon Cap and Trade						
subtotal	**147**	**$140**	**$258**	**190**	**$258**	**$188**
Transport Sector						
Vehicle Travel Reductions	29	-$50	-$496	37	-$126	-$495
LDV efficiency improvements	38	-$19	-$270	136	-$149	-$296
HDV efficiency improvements	8	-$3	-$179	33	-$22	-$214
Aircraft efficiency improvements	10	-$3	-$106	28	-$14	-$129
Greenhouse Gas Standards	11	$7	$227	22	$25	$237
subtotal	**95**	**-$68**	**-$272**	**255**	**-$286**	**-$265**
TOTAL	436	-$111	-$80	954	-$561	-$121

It is important to note that the large net savings achieved by the energy efficiency policies create the "economic space" into which policies for fuel shifting to low emissions and renewable energy resources and technologies and step, while retaining overall net economic benefits. Rather than limiting policies to those with net benefits at the margin, this approach takes the longer view, by bringing cutting edge options into early use, thereby inducing technology learning and setting the stage for the deeper carbon reductions for which they will be needed in the future, while getting deeper carbon and emissions reductions in the near term.

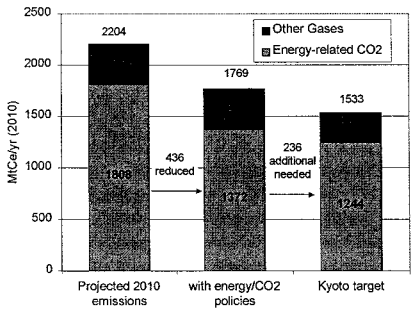
3. Achieving Kyoto

Energy-related CO_2 emissions are the predominant source of U.S. greenhouse gas emissions for the foreseeable future, and their reduction is the central and ultimate challenge for protecting the climate. Yet, with its delayed and weak emissions mitigation policies heretofore, the U.S. may not be able to rely solely on energy sector policies and technologies to meet its Kyoto obligation of emissions 7 percent reduction below 1990 levels with no net economic cost. As our analysis has shown, such efforts, if aggressively pursued, would slow our growth in energy sector CO_2 emissions from a projected 35 percent to 2.5 percent above 1990 levels by 2010 and still achieve a small net economic benefit. This would be a major accomplishment, but would still leave us 128 MtC/yr short of achieving a target of 1244 MtC/yr by 2010, if the Kyoto target were confined only to the domestic energy sector. A tighter carbon cap for the electric sector could increase domestic energy-related emission reductions to meet the Kyoto requirement, but this would incur incremental costs that could eliminate the net benefit and lead to a modest overall net cost.

Of course, there is more to the Kyoto agreement. The Kyoto targets cover six gases – methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF6) and carbon dioxide. The use of these gases is currently growing, due to the ongoing substitution of ozone depleting substances (ODS) with HFCs, and to a lesser extent, to growth in CH_4 emissions from livestock and coal and natural gas systems, in N_20 from fertilizer use, and in PFC emissions from semiconductor manufacture[30].

The U.S. commitment requires emissions of all six gases, in aggregate, to be reduced to 7 percent below their baseline levels.[31] When all of the six "Kyoto gases" are considered, baseyear emissions amount to 1680 MtCe/yr, making the -7 percent Kyoto reduction target equal to 1533 MtCe/yr, as shown in the third column of Figure 2. The projected 2010 emissions for all six gases is 2204 MtCe/yr (first column), thus the total required reduction is expected to be 672 MtCe/yr. The energy-CO_2 policies described in the previous sections yield 436 MtCe/yr in reductions by 2010 (second column), leaving the U.S. with 236 MtCe/yr additional reductions to achieve from other policies and measures.

Figure 2: Projected Emissions, 2010, All Gases



The Kyoto agreement provides us with several options for obtaining the additional 236 MtCe/yr of reductions. Two of these options involve domestic reductions: the control of non-CO_2 gases ("multi-gas control") and the use of "sinks" or biotic sequestration, through the land use, land use change and forestry options allowed under the Protocol. The other options involve obtaining credits and allowances from international sources. Under the Kyoto Protocol, countries can purchase

credits and allowances through the Clean Development Mechanism (CDM), Joint Implementation, or Emissions Trading (ET) to offset domestic emissions exceeding our 7 percent reduction target. This section examines how we might meet the Kyoto target through the use of these options, and what the costs and other implications might be.

3.1 Domestic Options

Article 3.3/3.4 and Sinks

GHG emissions and removals from land use and land use change and forestry (LULUCF) are a subject of great controversy and scientific uncertainty. The Kyoto Protocol treats LULUCF activities in two principal categories: afforestation, reforestation, and deforestation under Article 3.3, and "additional human-induced activities" such as forest and cropland management under Article 3.4. Different interpretations of these two articles can have widely varying impacts on the US reduction commitment.[32] For instance, the US estimate of business-as-usual forest uptake during the first commitment period is 288 MtCe/yr. If fully credited as an Article 3.4 activity, this uptake could provide credit equal to more than 40% of the US reduction requirement, with no actual mitigation effort. However, the vast majority of countries do not interpret the Protocol as allowing credit for business-as-usual offsets, and therefore believe they should be excluded.

Since our analysis was conducted prior to the July 2001 COP6bis meetings in Bonn, we based our LULUCF analysis on the "consolidated negotiating text" issued by Jan Pronk, President of COP6, in the weeks prior to the meeting.[33] The so-called "Pronk text" reflected an attempted compromise among various parties on a number of contentious issues, and was the basis for the final COP6bis outcome on LULUCF issues.[34] The Pronk text capped total US crediting from Article 3.4 activities and afforestation and reforestation projects in the CDM and JI at roughly 58 MtCe/yr.[35] Domestic forest management activities would be subject to an 85% discount. Thus, if one assumes the US estimate above, the Pronk rules would result in 42 MtCe/yr of essentially zero-cost credit for forest management activities that are expected to occur anyway.[36] In addition, agricultural management (e.g. no-till agriculture, grazing land management, revegetation) would be allowed under a net-net accounting approach that would allow the US to count another expected 10 MtCe/yr of business-as-usual, i.e. zero-cost, credit towards the cap. In sum, the Pronk proposal translates to 52 MtCe/yr of "free" carbon removals, and another 6 MtCe/yr that could be accrued through new domestic forest or agricultural management activities.[37]

Based on a recent summary of LULUCF cost estimates, we assumed that the 6MtCe/yr of "new" offsets allowable under the Pronk text would be purchased for $10/tCe.[38] A total of 58 MtCe/yr of LULUCF credit would therefore be available to help meet the reduction requirement of 236 MtCe/yr remaining after having adopted the energy-related CO_2 policies described above.

The net result of our analysis is slightly different than the implications of the COP6bis agreement. The agreement would allow approximately 28MtCe/yr of existing forest management, up to 16MtCe/yr of reforestation/afforestation through the CDM, and an unlimited amount of new Article 3.4 forest and agricultural management activities.[39] The difference is that the US would receive fewer "free" credits from business-as-usual activity, would need to pay a bit for domestic and CDM projects to reach the 58 MtCe/yr of assumed LULUCF activity

modeled here. However, the US would no longer be capped with respect to the generation of further Article 3.4 offsets, potentially offering an expanded pool of lower cost reduction opportunities than modeled here.

Multi-gas Control

Multi-gas control is a fundamental aspect of the Protocol, and its potential for lowering the overall cost of achieving Kyoto targets has been the subject of several prominent studies (Reilly et al., 1999 and 2000). Table 4 shows baseline and projected emission levels for the non-CO_2 gases.[40]

Table 4: Baseline and Projected Emissions for the Non-CO_2 Kyoto Gases (MtCe/yr)

Gas	Base Year (1990/95)	7% Below Base Year	Projected 2010	Reductions Required[(a)]	Sources
Methane	170	158	186	28	(USEPA 1999)
Nitrous Oxide	111	103	121	18	(Reilly et al. 1999b; USEPA 2001a)
High GWP Gases (HFC, PFC, SF6)	29	27	90	63	(USEPA 2000)
Total	310	288	397	109	

(a) These are the reductions that would be needed if each gas were independently required to be 7 percent below its base year level.

Methane emissions are expected to grow by only 10 percent from 1990 to 2010, largely because of increased natural gas leakage and venting (due to increased consumption), enteric fermentation and anaerobic decomposition of manure (due to increased livestock and dairy production). Methane from landfills, which accounted for 37 percent of total methane emissions in 1990, are expected to decline slightly as a consequence of the Landfill Rule of the Clean Air Act[41], which requires all large landfills to collect and burn landfill gases.

Several measures could reduce methane emissions well below projected levels. USEPA estimates that capturing the methane from landfills not covered by the Landfill Rule, and using it to generate electricity, is economically attractive at enough sites to reduce projected landfill emissions by 21 percent.[42] At a cost of $30/tCe, the number of economically attractive sites increases sufficiently that 41 percent of landfill emissions can be reduced. Similarly, USEPA has constructed methane reduction cost curves for reducing leaks and venting in natural gas systems, recovering methane from underground mines, using anaerobic digesters to capture methane from manure. and reducing enteric fermentation by changing how livestock are fed and managed.

We have used a similar USEPA study to estimate the emissions reductions available for the high GWP gases.[43] Table 1 shows that the high-GWP gases, while only a small fraction of baseline emissions (first column), are expected to rise so rapidly that they will account for majority of net growth in non-CO_2 emissions relative to the 7 percent reduction target (last column). In many applications, other gases can be substituted for HFCs and PFCs, new industrial process can implemented, leaks can be reduced, and more efficient gas-using equipment can be installed. For instance, minor repairs of air conditioning and refrigeration equipment could save an estimated 6.5 MtCe/yr in HFC emissions by 2010 at cost of about $2/tCe. New cleaning

processes for semiconductor manufacture could reduce PFC emissions by 8.6 MtCe/yr by 2010 at an estimated cost of about $17/tCe. In all, USEPA identified 37 measures for reducing high GWP gases, a list which is likely to be far from exhaustive given the limited experience with and data on abatement methods for these gases.

The major source of nitrous oxide in the U.S. is the application of nitrogen fertilizers, which results in about 70 percent of current emissions. Given the tendency of farmers to apply excess fertilizer to ensure good yields, effective strategies for N2O abatement from cropping practices has thus far been elusive. Thus, aside from measures to reduce N2O from adipic and nitric acid production (amounting to less than one MtCe/yr), and from mobile sources as a result of transportation policies (see below), we have not included a full analysis of N2O reduction opportunities[44].

Relying largely on recent USEPA abatement studies[45], we developed the cost curve for reducing non-CO_2 gases depicted in Figure 2 below.[46] In addition to what is covered in the USEPA studies, we assumed that:

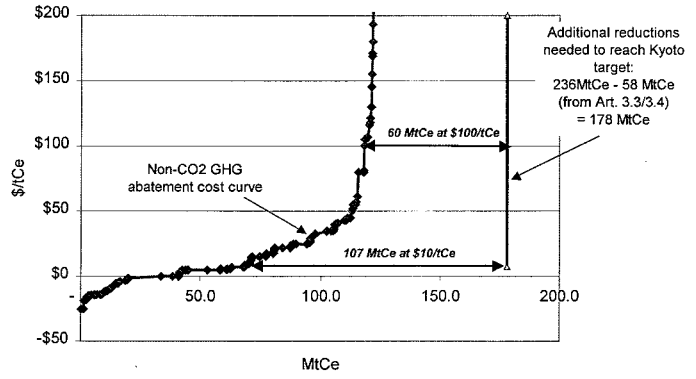
- Only 75 percent of the 2010 technical potential found in the USEPA studies would actually be achieved, and that policies and programs needed to promote these measures would add a transaction cost of $5/tCe.
- The savings in 2010 fossil fuel use resulting from the policies and measures implemented in the energy sector will yield corresponding benefits for several categories of non-CO_2 emissions. In particular, we assumed that a) reduced oil use in the transport sector (down 14 percent) will lead to a proportional decrease in N2O emissions from mobile sources[47]; b) reduced natural gas demand (down 13 percent) will result in proportionately fewer methane emissions from leaks and venting; and c) reduced coal production (down 49 percent) will lead to decreased underground mining and its associated emissions. [48]

Figure 3 shows that domestic options, taken together, are insufficient to reaching the Kyoto target. The line on the left is the "supply curve" of non-CO_2 abatement options, and the line on the right is the reduction requirement after both energy-related and Article 3.3/3.4 sinks are accounted for. Under current conditions (only 9 years left until 2010), the supply of remaining domestic options appears insufficient to satisfy demand. This gap ranges from 107 MtCe/yr at $10/tCe to 60 MtCe/yr at $100/tCe as shown. Therefore, to meet our Kyoto obligations, we are now in a situation of looking to the international market to fill this gap.

3.2 International Options

The Kyoto Protocol creates two principal types of greenhouse gas offsets in the international market: the purchase of surplus allowances from countries that are below their Kyoto targets and the creation of carbon credits through project-based mechanisms, CDM and JI.

Figure 3: Non-CO2 GHG Emissions Reductions, Cost and Potential, 2010



Emissions Allowance Trading/Hot Air

The combination of emission targets based on circa 1990 emissions and the subsequent restructuring and decline of many economies in transition (EITs) means that these countries could have a large pool of excess emissions allowances, typically referred to as "hot air" (see Appendix B). We assume that hot air will constitute no more than 50 percent of all international trading, and we assume a maximum availability of 200 MtCe/yr, based on a recent analysis.[49]

CDM and JI

CDM and JI projects, can be an important part of a comprehensive climate policy, providing they truly contribute to sustainable development in the host countries and create genuine, additional GHG benefits. It is reasonable to expect that the U.S. government and other stakeholders will want to develop the CDM and JI market in order to involve developing countries, engage in technology transfer, develop competitive advantages, and prepare for future commitment periods.

Similarly, the possibility of limited crediting lifetimes, or discounting of carbon reductions in future projects years, as proposed by some, could increase the effective cost per tCe. In a recent analysis, Bernow *et al.* (2000) illustrated how different approaches to standardizing baselines could lead to differences in additional power sector activity (tCe) of a factor of 4. These types of considerations are rarely included in CDM/JI analyses, either bottom-up or top-down.

Given the small differences between the two different approaches, we adopt the top-down results of the GTEM model,[50] since they provide a fuller CDM curve, include multiple gases, and provide a cost curve for JI investments as well.

3.3 Combining the Options

There are two ways to combine the available options to meet our Kyoto target. We can prioritize which options to rely on more heavily, based on their strategic advantages and co-benefits, as we have done for energy/CO_2 policies. Or we can simply seek lowest-cost solution for the near-term. A long-term climate policy perspective argues for the former approach. For example, rules and criteria for JI, and especially CDM, should be designed so that additionality, sustainability, and technology transfer are maximized. Ideally, our cost curves for CDM and JI would reflect only investments that are consistent with those criteria. However, our current ability to reflect such criteria in quantitative estimates of CDM and JI potential is limited.[51]

It is possible to model priority investment in the domestic reductions of non-CO_2 gases by implementing some measures that are higher cost than the global market clearing carbon price. Just as energy/CO_2 measures like a Renewable Portfolio Standard can be justified by the technological progress, long-term cost reductions, other co-benefits that they induce, so too can some non-CO_2 measures. While we have not attempted to evaluate specific policies for non-CO_2 gases as we have for CO_2, we have picked a point on the non-CO_2 cost curve, $100/tCe, to reflect an emphasis on domestic action. At $100/tCe, domestic non-$CO_2$ measures can deliver 118 MtCe/yr of reductions, still about 60 MtCe/yr short of the Kyoto goal, to which we must turn to the international market.

To model the global emissions trading market, we used the CDM/JI cost curves, and hot air assumptions described above, together with assumptions regarding the demand for credits and allowances from all Annex B parties.[52] This model yields market-clearing prices and quantities for each of the three principal flexible mechanisms: CDM, JI, and ET/hot air.[53] The results are shown in Table 5.

Table 5: Reductions Available in 2010 Up From Various Sources (in MtCe)

	Domestic Options		International Trade			
	Non-CO_2 gases	Sinks	CDM	JI	Hot air (ET)	Total
Amount available at < or = $0/tCe (MtCe)	41	52				93
Amount available at $0-$100 (MtCe)	77	6				83
Amount available at $8 (MtCe)			30	6	25	60
Annual costs ($Million)	$1,783	$60	$235	$48	$196	$2,322

The first row of the table shows that 93 MtCe/yr are available at net savings or no net cost, over half from the non-additional or "anyways" forest management and other Article 3.4 sinks activities implicit in the Pronk text. Another 77 MtCe/yr of non-CO_2 gas savings are available as we climb the cost curve from $0-100/tC (second row). The net result is that nearly $1.8 billion per year is invested in technologies and practices to reduce non-CO_2 GHG emissions by 118 MtCe/yr in 2010. Another $60 million per year is directed toward the 6 MtCe/yr of expected additional sinks projects allowed under the Pronk proposal. The third row shows that of the 60 MtCe/yr of international trading, half comes from CDM projects, and much of the rest from hot air. The model we use

estimates a market-clearing price of about $8/tCe for this 60 MtC/yr of purchased credits and allowance, amounting to a total annual cost of less than $500 million.[54]

In summary, of the 672 MtCe/yr in total reductions needed to reach Kyoto by 2010, nearly 65 percent comes from energy sector CO_2 reduction policies, 18 percent from domestic non-CO_2 gas abatement, 9 percent from domestic sinks, and 9 percent from the international market. The net economic benefits deriving from the energy-related carbon reductions reach nearly $50 billion/yr in 2010. The total annual cost for the 35 percent of 2010 reductions coming those last three options – non-CO_2 control, sinks, and international trading – is estimated at approximately $2.3 billion, making the total package a positive economic portfolio by a large margin. Had we taken the other approach noted at the beginning of the section – aiming for the lowest near-term compliance cost – we would rely more heavily on international trading. We modeled this scenario, and found that it would nearly double the amount of international trading, and lower the overall annual cost to $0.9 billion, and reduce the amount of non-CO_2 control by over 40 percent. This additional benefit is minor in comparison to the economic and environmental benefits of the entire policy portfolio.

4. Conclusions

This study shows that the United States can achieve its carbon reduction target under the Kyoto Protocol – 7 percent below 1990 levels for the first budget period of the Protocol. Relying on national policies and measures for greenhouse gas reductions, and accessing the flexibility mechanisms of the Kyoto Protocol for a small portion of its total reductions, the U.S. would enjoy net economic savings as a result of this Climate Protection package. Such action would lead to carbon emission reductions of about 24 percent by 2010 relative to the Base Case, bringing emissions to about 2.5 percent above 1990 levels. Furthermore, emissions of other pollutants would also be reduced, thus improving local air quality and public health. A strategy that relies entirely upon domestic energy-related carbon reductions to meet the Kyoto requirement could also be pursued, e.g., with a tighter carbon cap or higher RPS for the electric sector. This could require some incremental costs and thus reduce the overall net benefit found here for the policies modeled (or incur a small net cost), but with increased pollutant reduction and ancillary benefits.

Adopting these policies at the national level through legislation will not only help America meet its Kyoto targets but will also lead to economic savings for consumers, as households and businesses would enjoy annual energy bill reductions in excess of their investments. These net annual savings would increase over time, reaching nearly $113 per household in 2010 and $375 in 2020. The cumulative net savings would be about $114 billion (present value 1999$) through 2010 and $576 through 2020. By the year 2020 estimated incremental jobs are about the 1.3 million and GDP increase is about $44 billion.

While implementing this set of policies and additional non-energy related measures is an ambitious undertaking, it represents an important transitional strategy to meet the long-term requirements of climate protection. It builds the technological and institutional foundation for much deeper long-term emission reductions needed for climate protection. Such actions would stimulate innovation and invention here in the U.S. while positioning the U.S. as a responsible international leader in meeting the global challenge of climate change.

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[1] A somewhat modified version of this article will appear in *CLIMATE CHANGE POLICY: A SURVEY*, edited by Stephen H. Schneider, Armin Rosencranz and John O. Niles to be published by Island Press in July 2002. It is based on analyses conducted for World Wide Fund for Nature (WWF) http://www.panda.org/climate/ and published in two reports -- *The American Way to the Kyoto Protocol* (Alison Bailie, Stephen Bernow, William Dougherty, Michael Lazarus, and Sivan Kartha -- Tellus Institute (www.tellus.org), July 2001) and *Clean Energy: Jobs for America's Future* (Alison Bailie, Stephen Bernow, William Dougherty, Michael Lazarus and Sivan Kartha -- Tellus Institute and Marshall Goldberg -- MRG & Associates, October 2001) Important input to these studies was provided on energy efficiency (by colleagues at American Council for an Energy-efficient Economy) and on renewable energy (by colleagues at Union of Concerned Scientists and other experts).

[2] EIA, 2001a. *Annual Energy Outlook 2001 with Projections to 2020.* U.S. Department of Energy, Washington D.C.

EIA, 2001b. *U.S. Carbon Dioxide Emissions from Energy Sources, 2000 Flash Estimate. U.S.* Department of Energy. http://www.eia.doe.gov/oiaf/1605/flash/sld001.htm

[3] Under Kyoto, the base year for three of the non-CO2 GHGs (HFCs, PFCs, SF6) is 1995, not 1990, and the 1995 levels for these emissions are reported here.

[4] Savings are in 1999 $. The 2010 savings include $2.3 billion costs per year ($9 billion cumulative through 2010) of non-energy related measures needed to meet the Kyoto target. Costs are not included in 2020 since these measures policies do not extend past 2010.

[5] Impacts were made using an I-O model, taking account of productivity trends, and assuming that there is otherwise less than full employment in those job/skill areas that would be required by the shifts from energy to other demands caused by the policies.

[6] ACEEE, 1999. *Meeting America's Kyoto Protocol Targets.* H. Geller, S. Bernow and W. Dougherty. Washington, D.C.: American Council for an Energy-Efficient Economy.

[7] Throughout this report we refer to U.S. emissions target for the year 2010 to mean the average of the five year period from 2008 to 2012.

[8] Same as ACEE, 1999.

[9] Bernow, S. K. Cory, W. Dougherty, M. Duckworth, S.Kartha and M. Ruth, 1999. *America's Global Warming Solutions.* Washington, D.C.: World Wildlife Fund.

[10] EIA, 2001a. *Annual Energy Outlook 2001 with Projections to 2020.* U.S. Department of Energy, Washington D.C.

EIA, 2001b. *U.S. Carbon Dioxide Emissions from Energy Sources, 2000 Flash Estimate. U.S.* Department of Energy. http://www.eia.doe.gov/oiaf/1605/flash/sld001.htm

[11] BCAP, 1999. *Status of State Energy Codes.* Washington, D.C.: Building Codes Assistance Project, Sept./Oct.

[12] Ibid

[13] Nadel, S. and H. Geller, 2001. *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions though Greater Energy Efficiency.* American Council for and Energy-Efficient Economy, with Tellus Institute. Report No. E012. Washington, D.C.

[14] The bills include those introduced by Senators Murkowski and Lott (S.389); Bingaman and Daschle (S.596), Smith (S.207), Hatch (S.760), and Representative Nussle (H.R. 1316).

[15] Nadel, Steven and Marty Kushler. 2000. "Public Benefit Funds: A Key Strategy for Advancing Energy Efficiency." *The Electricity Journal.* Oct., pp. 74-84.

[16] EERE, 2000. *Scenarios for a Clean Energy Future*, Prepared by the Interlaboratory Working Group on Energy-Efficient and Clean-Energy Technologies, Washington, D.C.: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

[17] EPA, 2001. "The Power of Partnerships, Climate Protection Partnerships Division, Achievements for 2000—In Brief." Washington, D.C.: U.S. Environmental Protection Agency.

Brown, Rich, Carrie Webber, and Jon Koomey, 2000. "Status and Future Directions of the ENERGY STAR Program," In *Proceedings of the 2000 ACEEE Summer Study on Energy Efficiency in Buildings*, 6.33–43. Washington, D.C.: American Council for an Energy-Efficient Economy.

[18] Elliott, R. N. and M. Spurr, 1999. *Combining Heat and Power: Capturing Wasted Energy.* Washington, D.C.:American Council for an Energy-Efficient Economy.

[19] Burtraw, D., K. Palmer, R. Barvikar and A. Paul, 2001. *The Effect of Allowance Allocation on the Costs of Carbon Emissions Trading.* Discussions Paper 01-30. Washington, D.C.: Resources for the Future.

[20] Assuming a mean value at a market price of oil of $20/barrel.
U.S. Geological Survey, 2001. Arctic National Wildlife Refuge, 1002 Area, Petroleum Assessment, 1998, Including Economic Analysis. Fact Sheet FS-028-01, April. (See also U.S. Geological Survey, 1999. The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska. USGS Open File Report 98-34.

[21] Assuming a retail price of gasoline of $1.50/gallon, a 10-year life of the vehicle, and 12,000 miles per year.

[22] Assuming typical load factors of 0.33 for autos and 0.6 for air.

[23] Lee, J.J., S.P. Lukachko, L.A. Waitz and A. Schaefer, 2001. "Historical and Future Trends in Aircraft Performance, Cost and Emissions." Forthcoming in *Annual Review of Energy and the Environment*, Vol 26. November.
Office of Technology Assessment, 1994. *Saving Energy in U.S. Transportation*, OTA-ETI-589, Washington, D.C.
Interlaboratory Working Group, 2000. *Scenarios for a Clean Energy Future.*Argonne National Laboratory, the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory and Pacific Northwest National Laboratory. Commissioned by DOE Office of Energy Efficiency and Renewable Energy. http://www.ornl.gov/ORNL/Energy_EFF/CEF.htm.

[24] Walsh, M., B. Perlack, D. Becker, A. Turhollow and R. Graham, 1997. *Evolution of the Fuel Ethanol Industry: Feedstock Availability and Price. Biofuels Feedstock* Development Program. Oak Ridge, TN: Oak Ridge National Laboratory.
Walsh, M., R. Perlack, D. Becker, A. Turhollow, D. Ugarte, D. Becker and R. Graham, S. Slinsky and D. Ray, 1999. *Biomass Feedstock Availability in the United States: Draft.* Oak Ridge National Laboratory. Oak Ridge Tennessee. April.

[25] Lynd., L. 1997. "Cellulosic Ethanol Technology in Relation to Environmental Goals and Policy Formulation." in J. DeCicco and M. DeLucchi, eds., *Transportation, Energy and Environment: How Far Can Technology Take Us?* Washington, D.C.: American Council for an Energy-Efficient Economy.

[26] Interlaboratory Working Group, 2000, same as above.

[27] USDOT 1997 U.S. Department of Transportation, 1997. *High-Speed Ground Transportation for America.* Federal Railroad Administration. Washington, D.C.

[28] USDOT 1997, same as above.

[29] A 5 percent discount rate was used for carbon as well as costs in the cost of saved carbon computations, based on the presumption that they will have a commodity value within some form of tradable permits regime.

[30] USEPA, 2001. "The Power of Partnerships, Climate Protection Partnerships Division, Achievements for 2000—In Brief." Washington, D.C.: U.S. Environmental Protection Agency.

[31] These gases can be controlled interchangeably, using 100 year Global Warming Potentials (GWP), so long as the total carbon-equivalents (C_e) are reduced to 93 percent of their baseline levels. In contrast to the main three gases (CO2, CH4, and N2O), which have a 1990 base year, the high GWP gases have a base year of 1995.

[32] For instance, different accounting methods and rules have been considered regarding: a) what constitutes a forest; b) which biotic pools and lands are counted; c) which activities are considered eligible for crediting under Article 3.4; and d) uncertainties in measuring above and below ground carbon stocks.

[33] See "Consolidated negotiating text proposed by the President", as revised June 18, 2001, FCCC/CP/2001/2/Rev.1, http://www.unfccc.int/resource/docs/cop6secpart/02r01.pdf

[34] See FCCC/CP/2001/L.7. Review of the implementation of commitments and of other provisions of the Convention. Preparations for the first session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (Decision 8/CP.4). Decision 5/CP.6. Implementation of the Buenos Aires Plan of Action.

[35] The Pronk text, along with the COP6bis agreement, prohibits first commitment period crediting of CDM projects that avoid deforestation.

[36] This figure is drawn from the Annex Table 1 of the April 9 draft of the Pronk text, which adopts Pronk adopts the accounting approach for Article 3.3. activities suggested by the IPCC Special Report of LULUCF. This approach yields an Article 3.3 debit of 7 MtCe/yr from net afforestation, reforestation, and deforestation

activity, which under the Pronk approach could be offset fully by undiscounted forest management activities. Thus the 42 MtCe/yr estimate is based on 85% x (288 – 7) MtCe/yr.

[37] The Pronk proposal also allowed this cap to be filled through afforestation and deforestation activities in the CDM.

[38] Missfeldt and Haites (2001) use a central estimate of 50 MtCe/year at $7.50/tCe for CDM afforestation and reforestation projects. They also assume the availability of 150 MtCe/year at $15/tCe for Article 3.4 sinks in Annex B countries. Note however that the Pronk 85% discount on forest management projects would, in principle, increase their cost accordingly (by 1/.15 or 6.7 times). However, given the relatively small quantity (6 MtCe) that could be purchased, lower cost opportunities in cropland management or the CDM should more than suffice.

[39] This figure is listed in a footnote to the agreement, since the US was not a party to it.

[40] USEPA (1999, 2000) expects voluntary Climate Change Action Plan (CCAP) activities to reduce 2010 methane and high GWP gas emissions by about 10 percent and 15 percent, respectively, reductions that are not included in their 2010 projections shown in Table 1. Instead these reductions are embodied in both their and our cost curves.

[41] USEPA, 1999, same as above.

[42] USEPA, 1999. *U.S. Methane Emissions 1990 – 2020: Inventories, Projections, and Opportunities for Reductions*, U.S. Environmental Protection Agency, Office of Air and Radiation, September . http://www.epa.gov/ghginfo.

[43] USEPA, 2000. *Estimates of U.S. Emissions of High-Global Warming Potential Gases and the Costs of Reductions*, Review Draft, Reid Harvey, U.S. Environmental Protection Agency, Office of Air and Radiation, March. http://www.epa.gov/ghginfo.

[44] USEPA, 2001b. Draft U.S. Nitrous Oxide Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions. EPA, Washington, DC, September, 2001.

[45] USPEA, 1999, 2000, 2001b, same as above.

[46] The result is a cost curve that is similar and more up-to-date than that used in widely cited multiple gas studies (Reilly et al, 1999a; Reilly et al, 1999b; EERE, 2000).

[47] A similar assumption is used by European Commission (1998). Approximately fifteen percent of N2O emissions are a byproduct of fuel combustion, largely by vehicles equipped with catalytic converters (USEPA, 2001a).

[48] We assume that coal production is a proportional to coal use (i.e. we ignore net imports/exports). USEPA expects that the marginal methane emissions rate will increase with production as an increasing fraction is expected to come from deeper underground mines (USEPA, 1999).

[49] Victor, David G., Nakicenovic, Nebojsa, and Victor, Nadejda, 2001, "The Kyoto Protocol Emission Allocations: Windfall Surpluses for Russia and Ukraine," Climatic Change 49 (3):263-277, May 2001.

[50] Grütter, J. 2001. *World Market for GHG Emission Reductions: An analysis of the World Market for GHG abatement, factors and trends that influence it based on the CERT model.* Prepared for the World Bank's National AIJ/JI/CDM Strategy Studies Program, March, 2001.

[51] We did briefly examine the potential contribution of a CDM fast track for renewables and efficiency, as embodied in the Pronk text. Applying the power sector CDM model developed by Bernow et al (2001), we found that a carbon price of $20/tCe would induce only 3 MtCe/yr of new renewable energy project activity by 2010. At a price of $100/tCe, this amount rises to 18 MtCe/yr. Given that a large technical potential for energy efficiency projects exists at low or negative cost per tCe, fast track efficiency projects (under 5 MW useful energy equivalents according to Pronk text) could significantly increase the amount available at lower costs.

[52] For the estimated demand for CDM, JI, and ET/hot air from other Annex 1 parties, we used a combination of EPPA and GTEM cost curves.[52] (Reilly et al, 1999b, and Ellerman and Decaux, 1998; Vrolijk and Grubb, 2000; Grutter, 2001).

[53] Our approach is similar to that used in a few other recent studies (Grutter, 2001; Haites, 2000; Missfeldt and Haites, 2001; Krause et al, 2001; Vrolijk and Grubb, 2000).

[54] The market clearing price is lower here than in other similar studies, due in large part to a much lower U.S. demand for international trade, which results from of our aggressive pursuit of domestic abatement options and the fact that we assume that domestic policies and investments should be done as a matter of sound energy and environmental policy (i.e. they are price-inelastic).

Total Energy Consumption by Fuel and by Sector in 1990 (Quads)

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.06	0.10	2.75	0.00	16.20	19.11
Oil	1.27	0.91	8.31	21.81	1.23	33.53
Gas	4.52	2.76	8.47	0.68	2.88	19.31
Nuclear	0.00	0.00	0.00	0.00	6.19	6.19
Hydro	0.00	0.00	0.00	0.00	2.99	2.99
Non-Hydro	0.83	0.09	2.07	0.00	0.50	3.49
Primary Total	**6.68**	**3.86**	**21.60**	**22.49**	**29.99**	**84.62**
Electricity	3.15	2.86	3.24	0.01		9.26
End-Use Total	**9.83**	**6.72**	**24.84**	**22.50**		**63.89**

Total Energy Consumption by Fuel and by Sector in 2005 (Quads), Base Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.07	2.62	0.00	21.43	24.18
Oil	1.42	0.66	9.95	29.06	0.32	41.41
Gas	5.46	3.71	10.43	0.83	5.41	25.84
Nuclear	0.00	0.00	0.00	0.00	7.90	7.90
Hydro	0.00	0.00	0.00	0.00	3.08	3.08
Non-Hydro	0.43	0.08	2.42	0.03	1.10	4.06
Primary Total	**7.36**	**4.52**	**25.42**	**29.91**	**39.25**	**106.46**
Electricity	4.49	4.34	3.90	0.09		12.82
End-UseTotal	**11.85**	**8.86**	**29.32**	**30.00**		**80.04**

Total Energy Consumption by Fuel and by Sector in 2005 (Quads). Policy Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.07	2.25	0.00	17.26	19.63
Oil	1.41	0.64	9.40	27.80	0.23	39.49
Gas	5.35	3.74	10.27	0.83	4.48	24.67
Nuclear	0.00	0.00	0.00	0.00	7.90	7.90
Hydro	0.00	0.00	0.00	0.00	3.12	3.12
Non-Hydro	0.43	0.08	2.46	0.21	4.03	7.21
Primary Total	**7.23**	**4.53**	**24.39**	**28.84**	**37.03**	**102.02**
Electricity	4.27	4.01	3.38	0.09		11.75
End-UseTotal	**11.50**	**8.54**	**27.77**	**28.93**		**76.74**

Total Energy Consumption by Fuel and by Sector in 2010 (Quads), Base Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.07	2.62	0.00	22.41	25.16
Oil	1.29	0.67	10.55	31.74	0.19	44.43
Gas	5.70	3.89	11.14	0.99	6.97	28.69
Nuclear	0.00	0.00	0.00	0.00	7.69	7.69
Hydro	0.00	0.00	0.00	0.00	3.08	3.08
Non-Hydro	0.43	0.08	2.64	0.04	1.60	4.79
Primary Total	**7.47**	**4.71**	**26.95**	**32.77**	**41.94**	**113.84**
Electricity	4.95	4.86	4.17	0.12		14.10
End-UseTotal	**12.42**	**9.57**	**31.12**	**32.89**		**86.00**

Total Energy Consumption by Fuel and by Sector in 2010 (Quads). Policy Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.07	2.09	0.00	10.74	12.95
Oil	1.26	0.62	9.15	27.38	0.28	38.70
Gas	5.39	3.93	10.73	0.99	6.33	27.37
Nuclear	0.00	0.00	0.00	0.00	7.91	7.91
Hydro	0.00	0.00	0.00	0.00	3.12	3.12
Non-Hydro	0.43	0.08	2.76	0.54	7.02	10.83
Primary Total	**7.13**	**4.71**	**24.74**	**28.91**	**35.40**	**100.88**
Electricity	4.12	3.79	2.91	0.12		10.93
End-UseTotal	**11.25**	**8.49**	**27.64**	**29.03**		**76.41**

Percentage Difference in Primary Consumption by 2010 Relative to 1990

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	-13%	-28%	-24%	NA	-34%	-32%
Oil	-1%	-32%	10%	26%	-77%	15%
Gas	19%	42%	27%	45%	120%	42%
Nuclear	NA	NA	NA	NA	28%	28%
Hydro	NA	NA	NA	NA	4%	4%
Non-Hydro	-48%	-8%	33%	NA	1304%	210%
Primary Total	**7%**	**22%**	**15%**	**29%**	**18%**	**19%**
Electricity	31%	32%	-10%	1081%		18%
Total	**14%**	**26%**	**11%**	**29%**		**20%**

Total Energy Consumption by Fuel and by Sector in 2015 (Quads), Base Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.07	2.62	0.00	22.97	25.72
Oil	1.24	0.67	11.15	34.29	0.18	47.52
Gas	5.99	4.05	11.78	1.12	9.37	32.32
Nuclear	0.00	0.00	0.00	0.00	6.79	6.79
Hydro	0.00	0.00	0.00	0.00	3.07	3.07
Non-Hydro	0.43	0.08	2.86	0.04	1.59	5.01
Primary Total	**7.71**	**4.88**	**28.41**	**35.45**	**43.97**	**120.42**
Electricity	5.36	5.30	4.44	0.15		15.25
End-UseTotal	**13.08**	**10.18**	**32.85**	**35.60**		**91.70**

Total Energy Consumption by Fuel and by Sector in 2015 (Quads). Policy Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.07	1.99	0.00	5.70	7.81
Oil	1.18	0.58	8.70	25.65	0.13	36.25
Gas	5.31	4.05	11.48	1.12	5.85	27.81
Nuclear	0.00	0.00	0.00	0.00	7.60	7.60
Hydro	0.00	0.00	0.00	0.00	3.11	3.11
Non-Hydro	0.43	0.08	3.02	0.79	7.50	11.83
Primary Total	**6.98**	**4.79**	**25.19**	**27.56**	**29.89**	**94.42**
Electricity	3.77	3.20	2.18	0.15		9.29
End-UseTotal	**10.75**	**7.99**	**27.37**	**27.71**		**73.82**

Percentage Difference in Primary Consumption by 2015 Relative to 1990

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	-16%	-26%	-28%	NA	-65%	-59%
Oil	-7%	-37%	5%	18%	-89%	8%
Gas	18%	47%	35%	65%	103%	44%
Nuclear	NA	NA	NA	NA	23%	23%
Hydro	NA	NA	NA	NA	4%	4%
Non-Hydro	-48%	-8%	46%	NA	1400%	239%
Primary Total	**5%**	**24%**	**17%**	**23%**	**0%**	**12%**
Electricity	20%	12%	-33%	1355%	NA	0%
Total	**9%**	**19%**	**10%**	**23%**	**NA**	**16%**

Total Energy Consumption by Fuel and by Sector in 2020 (Quads), Base Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.08	2.62	0.00	23.50	26.24
Oil	1.21	0.66	11.78	36.77	0.20	50.62
Gas	6.31	4.14	12.38	1.24	11.40	35.48
Nuclear	0.00	0.00	0.00	0.00	6.09	6.09
Hydro	0.00	0.00	0.00	0.00	3.06	3.06
Non-Hydro	0.44	0.08	3.08	0.05	1.62	5.27
Primary Total	**8.01**	**4.96**	**29.86**	**38.06**	**45.87**	**126.76**
Electricity	5.80	5.59	4.79	0.17		16.34
End-UseTotal	**13.81**	**10.54**	**34.65**	**38.23**		**97.23**

Total Energy Consumption by Fuel and by Sector in 2020 (Quads), Policy Case

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	0.05	0.08	1.90	0.00	2.45	4.48
Oil	1.13	0.52	8.34	25.15	0.07	35.21
Gas	5.26	4.09	12.38	1.24	4.63	27.61
Nuclear	0.00	0.00	0.00	0.00	6.90	6.90
Hydro	0.00	0.00	0.00	0.00	3.11	3.11
Non-Hydro	0.44	0.08	3.27	1.05	7.18	12.03
Primary Total	**6.88**	**4.77**	**25.90**	**27.45**	**24.35**	**89.34**
Electricity	3.46	2.49	1.45	0.17		7.56
End-UseTotal	**10.34**	**7.26**	**27.34**	**27.61**		**72.56**

Percentage Difference in Primary Consumption by 2020 Relative to 1990

	Residential	Commercial	Industrial	Transportation	Electricity	Total
Coal	-19%	-24%	-31%	NA	-85%	-77%
Oil	-11%	-43%	0%	15%	-94%	5%
Gas	16%	48%	46%	83%	61%	43%
Nuclear	NA	NA	NA	NA	12%	12%
Hydro	NA	NA	NA	NA	4%	4%
Non-Hydro	-47%	-8%	58%	NA	1337%	245%
Primary Total	**3%**	**24%**	**20%**	**22%**	**-19%**	**6%**
Electricity	10%	-13%	-55%	1559%	NA	-18%
Total	**5%**	**8%**	**10%**	**23%**	**NA**	**14%**

Carbon Emissions in 1990 (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	41.2	26.8	408.8	NA	476.8
Residential	65.0	24.0	1.6	162.4	253.0
Commercial	38.7	18.1	2.3	147.5	206.6
Industrial	119.6	91.9	67.8	166.3	445.6
Transportation	9.9	422.3	0.0	0.7	432.9
Totals	274.4	583.1	480.5	0.0	1,338.0
Fossil Fuel Share	20.5%	43.6%	35.9%		
Elect. Share					35.6%

Carbon Emissions in 2005 -- Base Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	77.9	7.0	544.0	NA	628.9
Residential	78.6	26.9	1.3	220.4	327.1
Commercial	53.5	12.9	1.8	212.9	281.0
Industrial	150.2	99.6	66.6	191.3	507.7
Transportation	11.9	557.2	0.0	4.3	573.5
Totals	372.1	703.6	613.6	0.0	1,689.3
Fossil Fuel Share	22.0%	41.7%	36.3%		
Elect. Share					37.2%

Carbon Emissions in 2005 -- Policy Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	64.7	5.1	438.5	NA	508.3
Residential	77.0	26.6	1.3	178.4	283.2
Commercial	53.8	12.5	1.8	173.2	241.3
Industrial	147.9	89.6	57.2	150.4	445.1
Transportation	11.9	533.1	0.0	4.3	549.4
Totals	355.3	666.9	498.8	0.0	1,521.1
Fossil Fuel Share	23.4%	43.8%	32.8%		
Elect. Share					33.4%

Carbon Emissions in 2010 -- Base Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	100.4	4.2	568.8	NA	673.4
Residential	82.0	24.4	1.3	236.5	344.3
Commercial	56.0	13.1	1.9	232.2	303.2
Industrial	160.4	105.9	66.4	199.0	531.8
Transportation	14.2	608.9	0.0	5.6	628.7
Totals	413.1	756.4	638.5	0.0	1,808.0
Fossil Fuel Share	22.9%	41.8%	35.3%		
Elect. Share					37.2%

Carbon Emissions in 2010 -- Policy Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	91.1	6.4	274.7	NA	372.1
Residential	77.6	23.8	1.3	128.5	231.2
Commercial	56.6	12.2	1.9	127.8	198.4
Industrial	154.6	80.0	53.0	106.4	394.0
Transportation	14.2	525.1	0.0	5.6	545.0
Totals	394.0	647.5	330.9	0.0	1,372.3
Fossil Fuel Share	28.7%	47.2%	24.1%		
Elect. Share					27.1%

Percentage Difference in Carbon Emissions in 2010 Relative to 1990

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	121%	-76%	-33%	NA	-22%
Residential	19%	-1%	-16%	-21%	-9%
Commercial	46%	-33%	-20%	-13%	-4%
Industrial	29%	-13%	-22%	-36%	-12%
Transportation	44%	24%	NA	706%	26%
Totals	44%	11%	-31%	NA	3%

Carbon Emissions in 2015 -- Base Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	135.0	4.0	583.1	NA	722.1
Residential	86.2	23.4	1.3	253.9	364.9
Commercial	58.4	13.1	1.9	250.9	324.3
Industrial	169.6	112.2	66.4	210.3	558.6
Transportation	16.2	657.6	0.0	6.9	680.6
Totals	465.4	810.3	652.7	0.0	1,928.4
Fossil Fuel Share	24.1%	42.0%	33.8%		
Elect. Share					37.4%

Carbon Emissions in 2015 -- Policy Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	84.4	3.0	148.3	NA	235.8
Residential	76.5	22.3	1.3	78.7	178.8
Commercial	58.3	11.3	1.9	79.1	150.6
Industrial	165.3	67.0	50.4	65.6	348.3
Transportation	16.2	491.4	0.0	6.9	514.5
Totals	400.7	595.0	202.0	0.0	1,197.7
Fossil Fuel Share	33.5%	49.7%	16.9%		
Elect. Share					19.7%

Percentage Difference in Carbon Emissions in 2015 Relative to 1990

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	105%	-89%	-64%	NA	-51%
Residential	18%	-7%	-19%	-52%	-29%
Commercial	51%	-38%	-17%	-46%	-27%
Industrial	38%	-27%	-26%	-61%	-22%
Transportation	63%	16%	NA	884%	19%
Totals	46%	2%	-58%	NA	-10%

Carbon Emissions in 2020 -- Base Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	164.1	4.5	596.4	NA	765.0
Residential	90.9	22.9	1.3	271.6	386.6
Commercial	59.6	12.9	2.0	261.6	336.0
Industrial	178.3	119.4	66.5	224.0	588.2
Transportation	17.9	705.1	0.0	7.8	730.8
Totals	510.9	864.7	666.1	0.0	2,041.6
Fossil Fuel Share	25.0%	42.4%	32.6%		
Elect. Share					37.5%

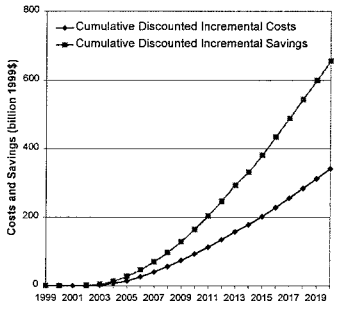
Carbon Emissions in 2020 -- Policy Case (Million metric tons)

Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	67.3	1.6	67.4	NA	136.3
Residential	75.8	21.2	1.3	44.0	142.3
Commercial	58.9	10.2	2.0	42.5	113.6
Industrial	178.3	55.7	48.3	36.4	318.7
Transportation	17.9	481.4	0.0	7.8	507.1
Totals	398.2	570.2	118.8	0.0	1,087.2
Fossil Fuel Share	36.6%	52.4%	10.9%		
Elect. Share					12.5%

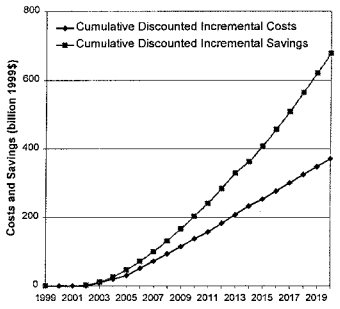
Percentage Difference in Carbon Emissions in 2020 Relative to 1990

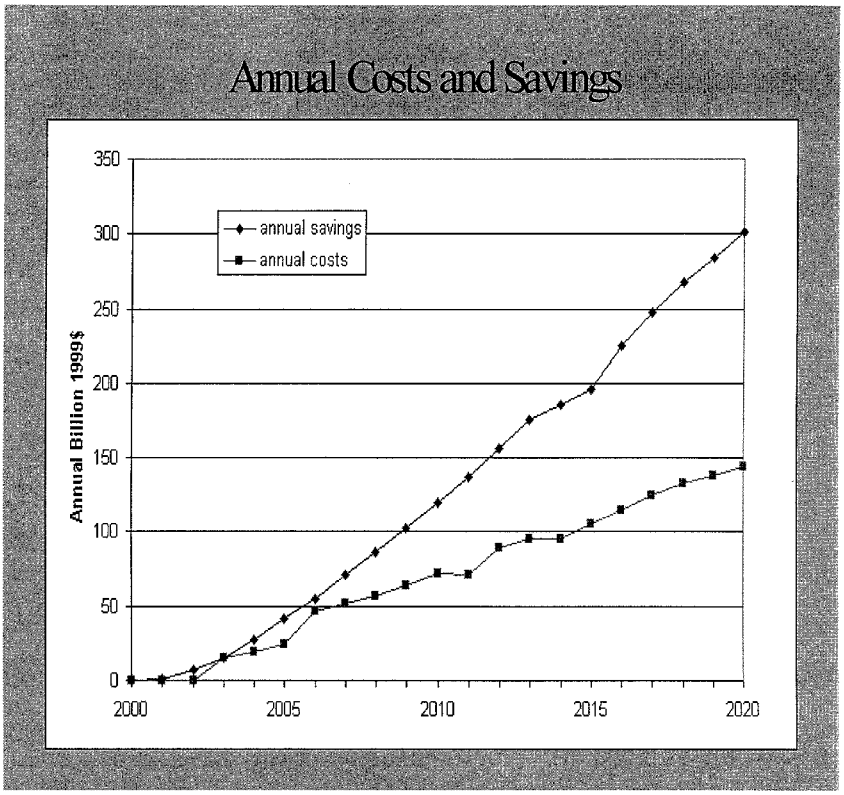
Sector	Gas	Oil	Coal	Indirect Electric	Totals
Electric	63.3%	-94.0%	-83.5%	NA	-71.4%
Residential	16.6%	-11.6%	-21.7%	-72.9%	-43.8%
Commercial	52.2%	-43.6%	-15.0%	-71.2%	-45.0%
Industrial	49.1%	-39.4%	-28.8%	-78.1%	-28.5%
Transportation	81.1%	14.0%	NA	1009.4%	17.1%
Totals	45.1%	-2.2%	-75.3%	NA	-18.7%

Cumulative Costs and Benefits – Households (billion $)



Cumulative Costs and Benefits– Business, Industry (billion $)




Annual Costs and Savings
350
300
250
200
150
100
50
0
Annual Billion 1999$
annual savings
annual costs
2000
2005
2010
2015
2020

Macro-Economic Impacts of the Policies: Methodology and Results

The overall energy and economic analyses starts with a business-as-usual energy-economic forecast based on the U.S. Department of Energy, Energy Information Administration's Annual Energy Outlook for 2001. This Base Case reflects a continuation of existing energy consumption and technology trends and policies, and presumes no efforts are taken to reduce greenhouse gas emissions.

Employment impacts from the policy scenarios were computed as net incremental impacts in specified future years. They are derived from the changes in expenditures on energy – operating costs and fuel costs -- brought about by investments in energy efficiency and renewable technologies, in each sector. The net impacts of these changes on the nation's economy were computed from these changes, including: 1) the net changes in employment; 2) the net changes in wage and salary compensation, measured in millions of 1998 dollars; and 3) the net changes in Gross Domestic Product (GDP), also measured in millions of 1998 dollars.

The analysis used data derived from IMPLAN (IMpact Analysis for PLANning), a widely used input-output (I-O) model that analyzes interactions between different sectors of the economy. IMPLAN was used to track the changes in each sector's demand and spending patterns, caused by changes in fuel consumption and energy technology investments owing to the policies, and the changes induced in other sectors' levels of output (and the inputs required). The analysis assumes that there is plant, materials and labor are underutilized; e.g., that there is unemployment in existing or potential skill areas the demand for which would be induced by the policies that shift expenditures to non-energy commodities.

The results of these interactions are captured through appropriate sectoral multipliers (jobs, income, and GDP per dollar of output). For each benchmark year (2010 and 2020), each change in a sector's spending pattern is matched to an appropriate sectoral multiplier. The analytical approach used here is similar to that in Geller, DeCicco and Laitner (1992), Laitner, Bernow and DeCicco (1998), Goldberg *et al.* (1998), and Bernow *et al.* (1999). These reports and the Annex can be referenced for a more in-depth discussion of methodological issues.

Input-output models were initially developed to trace supply linkages in the economy. Thus, the impacts generated from the policy scenario depend on the structure of the economy. For example, I-O models can show how increasing purchases of more efficient lighting equipment, more efficient cars, high efficiency motors, modular combined heat and power plants, or biomass energy not only directly benefit their respective producers, but also benefit those industries that provide inputs to the manufacturers. I-O models can also be used to show the benefits from indirect economic activity that occurs as a result of these transactions (e.g., banking and accounting services, among others) and the re-spending of energy bill savings throughout the economy. Therefore, spending patterns for energy have an effect on total employment, income (i.e., wage and salary compensation), and GDP.

For each sector of the economy multipliers were used to compute the impacts of the incremental expenditures. These multipliers identify the employment or economic activity generated from a given level of spending in each sector. Changes in expenditures were matched with appropriate multipliers. For instance, employment multipliers show the number of jobs that are directly and indirectly supported for each one million dollars of expenditure in a specific sector. For this

analysis, a job is defined as sufficient wages to employ one person full-time for one year. The employment multipliers for key sectors of the economy are listed in Table A.1, below.

The analysis in this study includes several modifications made to the methodology of merely matching expenditures and multipliers. First, it was assumed that 85 percent of the efficiency investments would be spent within the United States. While upgrades of energy efficiency are traditionally carried out by local contractors and dealers, this analysis recognizes that foreign suppliers and contractors may also be involved.

Second, we made an adjustment in the employment impacts to account for future changes in labor productivity in specific sectors. Utilizing data from the Bureau of Labor Statistics Economic and Employment Projections 1988, 1998, and 2008, we developed productivity trends for our analysis. These trends suggest that productivity rates are expected to vary widely among sectors. Annual productivity gains are forecast to range from 0.4 percent annually in the construction sector (which will experience a large influx of employment as those sectors become more important to the economy) to 7.4 percent annual productivity gain in oil and gas mining. These factors are given in Table A.2, below.

Third, we assumed that 80 percent of the investment upgrades would be financed by bank loans carrying an average 10 percent real interest rate over a five-year period. No parameters were established to account for changes in interest rates as less capital-intensive technologies (i.e., efficiency investments) are substituted for conventional supply strategies, or in labor participation rates. Although the higher cost premiums associated with the efficiency investments might be expected to increase the level of borrowing in the short term, and therefore, interest rates, this could be offset somewhat by avoided investments in new power plant capacity, exploratory well drilling, and new pipelines. Similarly, while a demand for labor may tend to increase the overall level of wages (and potentially lessen economic activity), the employment benefits from the scenario are relatively small compared with the national level of unemployment.

Fourth, for the residential and commercial sectors, it was assumed that program and marketing expenditures would be required to help promote market penetration of efficiency improvements due to the dispersed nature of the decision makers and the need for greater efforts towards market transformation. This was set at 15 percent of the efficiency investments for those sectors. No program or marketing expense was included for the industrial sector or transportation sector. We assume market penetration is naturally occurring in the industrial sector as decision makers adopt cost-effective and more efficient processes and older less efficient equipment is replaced with newer higher efficiency models. In the transportation sector efficiency improvements are assumed to be a part of all new vehicle purchases.

Finally, the analysis took account of the fact that the electric sector carbon cap and trade system, would involve government auctioning of carbon allowances to electricity suppliers. This was modeled by: (1) assuming purchases of the requisite allowances by utilities from the government, (2) payments for the corresponding higher costs of electricity by households and businesses, and (3) a return of the revenues collected by the government to households and businesses.

These results should be taken as indicative, as there are always limits to such a modeling exercise. The analyses do not account for feedback through final demand reductions, input

substitution owing to price changes, feedback from inflation, and the constraints on labor and money supplies. They also assume that available labor, plant and materials are not fully employed. Thus, for example, they assume that there is unemployment in those existing or potential skill areas the demand for which would be induced by the policies that shift expenditures to non-energy commodities. This is contrary to many other economic models, which in effect assume full employment, and that the shift in expenditures from energy to other commodities would not create new jobs.

On the other hand, while the models used for the energy analyses capture some policy-induced technology innovation, this is limited primarily to the electric sector. Moreover, the I-O analysis does not include the potential productivity benefits that could stem from the investments in new and more efficient equipment, and associated changes in organization, know-how and inter-industry interactions. Industrial investments that improve energy efficiency could be accompanied by improved product quality, lower capital and operating costs, increased employee productivity, easier and less costly environmental compliance, and entry into niche markets (see, e. g., Elliott et al. 1997; Laitner 1995; OTA 1993; Porter and Van Linde 1995). Even under full employment energy policies that improve the efficiency of the economy could increase incomes per worker. Finally, such job-inducing policies could help counteract recessionary business cycles. It would be valuable to develop tools and refine the analyses to account for some of these factors and obtain a more detailed characterization of the results.

For the state-by-state employment impacts, we developed indicative estimates of the distribution of the approximately 1.3 million net national jobs gained by 2020 across the fifty states and the District of Columbia. Absent a more detailed analysis of each individual state or region, we allocated the national job impacts by weighting the key variables to create an overall state-by-state assessment. This estimate reflects the significant energy and economic differences across the states. The key variables used in this assessment: differences in energy prices; the level of energy consumed for each dollar of economic activity in the state; the number of energy-related jobs as a percent of total state employment; and the number of state jobs as a percent of national employment. The results are presented in Table 2, which shows a positive net job impact in each state, ranging up to a high of about 140,000 in California by 2020.

Employment Multipliers for Select Economic Sectors

Sector	Multiplier
Agriculture	27.3
Other Mining	10.4
Coal Mining	9.9
Oil/Gas Mining	8.2
Construction	18.1
Food Processing	16.9
Other Manufacturing	13.3
Pulp and Paper Mills	11.6
Oil Refining	6.9
Stone, Glass, and Clay	13.2
Primary Metals	12.8
Metal Durables	13.1
Motor Vehicles	10.6
Transportation, Communication, and Utilities	13.9
Electric Utilities	5.2
Natural Gas Utilities	6.6
Wholesale Trade	13.4
Retail Trade	29.2
Finance	10.7
Insurance/Real Estate	8.1
Services	22.9
Education	28.9
Government	18.0

Labor Productivity Rates for Select Economic Sectors

Sector	Rate
Agriculture	1.6%
Other Mining	2.4%
Coal Mining	5.2%
Oil/Gas Mining	7.4%
Construction	0.4%
Food Processing	1.0%
Other Manufacturing	4.7%
Pulp and Paper Mills	3.0%
Oil Refining	3.3%
Stone, Glass, and Clay	2.2%
Primary Metals	4.0%
Metal Durables	4.7%
Motor Vehicles	2.0%
Transportation, Communication, and Other Utilities	2.5%
Electric Utilities	2.5%
Natural Gas Utilities	1.5%
Wholesale Trade	3.0%
Retail Trade	1.4%
Finance	3.7%
Insurance/Real Estate	0.8%
Services	1.1%
Education	1.0%
Government	0.4%

Macroeconomic Impacts of Policy Scenario by Sector, 2010

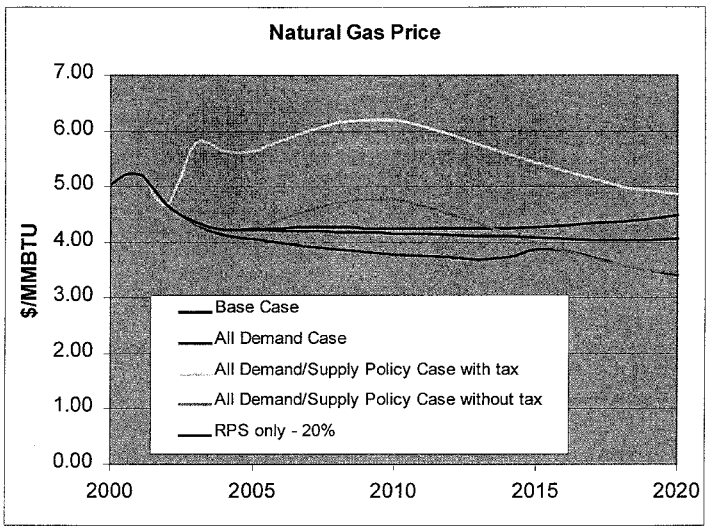
	Net Change in Jobs	Net Change in Wage and Salary Compensation (Million1998$)	Net Change in GDP (Million1998$)
Agriculture	18,600	$160	$530
Other Mining	6,900	$420	$880
Coal Mining	(10,100)	($990)	($2,090)
Oil/Gas Mining	(26,900)	($2,280)	($9,040)
Construction	353,200	$10,440	$14,990
Food Processing	2,700	$110	$210
Other Manufacturing	52,500	$3,980	$6,020
Pulp and Paper Mills	2,800	$240	$390
Oil Refining	(2,600)	($260)	($780)
Stone, Glass, and Clay	14,100	$750	$1,260
Primary Metals	11,800	$940	$1,360
Metal Durables	30,400	$2,140	$3,520
Motor Vehicles	36,500	$2,810	$4,610
Transportation, Communication, and Utilities	21,500	$1,100	$2,240
Electric Utilities	(18,400)	($1,900)	($10,070)
Natural Gas Utilities	(16,700)	($1,520)	($5,510)
Wholesale Trade	5,600	$350	$640
Retail Trade	14,400	$290	$510
Finance	31,600	$2,380	$4,890
Insurance/Real Estate	(5,900)	($160)	($1,110)
Services	191,900	$5,730	$8,080
Education	3,800	$140	$140
Government	27,200	$1,180	$1,550
Total	**744,900**	**$26,050**	**$23,220**

Macroeconomic Impacts of Policy Scenario by Sector, 2020

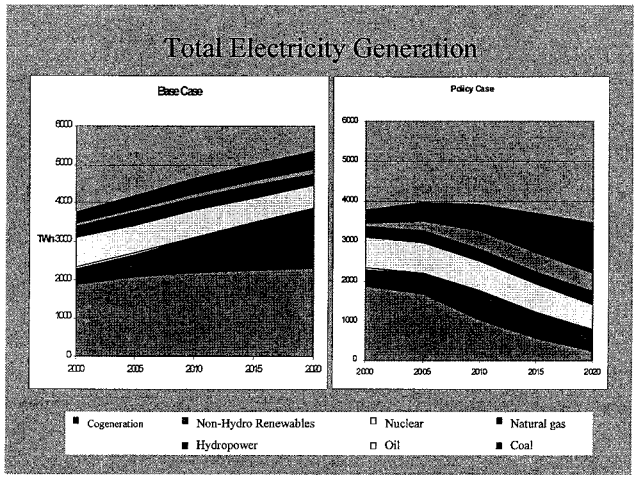
	Net Change in Jobs	Net Change in Wage and Salary Compensation (Million1998$)	Net Change in GDP (Million1998$)
Agriculture	63,100	$620	$2,120
Other Mining	11,200	$870	$1,830
Coal Mining	(23,900)	($2,340)	($4,940)
Oil/Gas Mining	(61,400)	($5,210)	($20,600)
Construction	340,300	$10,460	$15,030
Food Processing	16,100	$750	$1,380
Other Manufacturing	77,900	$9,360	$14,160
Pulp and Paper Mills	5,000	$570	$950
Oil Refining	(6,300)	($650)	($1,910)
Stone, Glass, and Clay	24,800	$1,630	$2,750
Primary Metals	18,600	$2,190	$3,180
Metal Durables	42,000	$4,670	$7,670
Motor Vehicles	54,300	$5,090	$8,350
Transportation, Communication, and Utilities	50,500	$3,320	$6,750
Electric Utilities	(35,100)	($5,180)	($27,540)
Natural Gas Utilities	(26,200)	($3,080)	($11,180)
Wholesale Trade	12,400	$1,030	$1,890
Retail Trade	190,300	$4,410	$7,680
Finance	42,100	$4,570	$9,410
Insurance/Real Estate	11,900	$350	$2,420
Services	394,600	$13,080	$18,460
Education	33,200	$1,330	$1,340
Government	78,900	$3,550	$4,660
Total	**1,314,300**	**$51,390**	**$43,860**

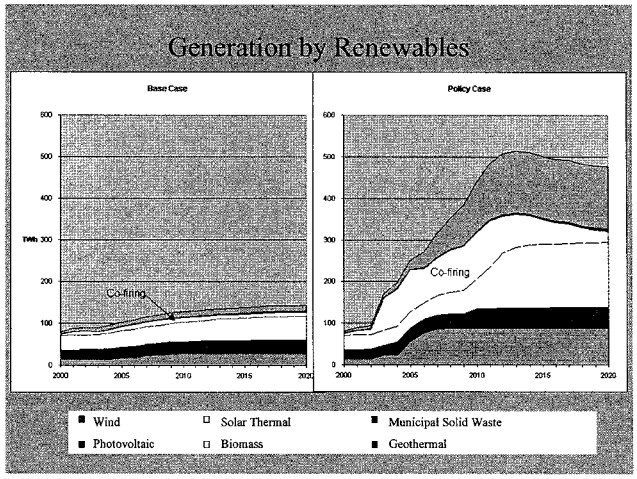
Job Impacts by State

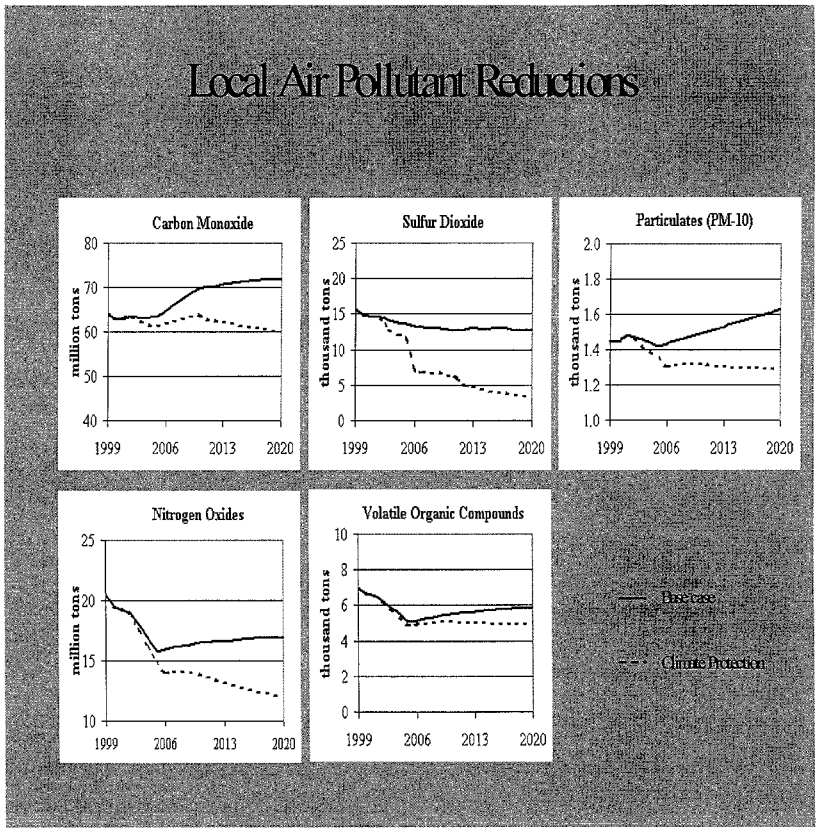
State	Net Job Gain 2010	Net Job Gain 2020
01 Alabama	13,100	22,600
02 Alaska	2,800	5,000
04 Arizona	11,200	19,900
05 Arkansas	7,500	13,200
06 California	77,400	141,400
08 Colorado	10,000	17,700
09 Connecticut	7,800	14,100
10 Delaware	2,200	3,800
11 District of Columbia	1,600	3,500
12 Florida	37,000	66,800
13 Georgia	21,300	38,300
15 Hawaii	2,700	5,000
16 Idaho	3,500	6,200
17 Illinois	31,900	56,400
18 Indiana	20,900	36,000
19 Iowa	8,300	14,700
20 Kansas	7,100	12,500
21 Kentucky	11,500	19,300
22 Louisiana	19,200	32,900
23 Maine	3,700	6,600
24 Maryland	12,500	22,000
25 Massachusetts	14,500	26,700
26 Michigan	29,800	51,000
27 Minnesota	13,400	24,000
28 Mississippi	7,200	12,600
29 Missouri	15,100	26,600
30 Montana	2,300	4,000
31 Nebraska	4,700	8,500
32 Nevada	5,300	9,100
33 New Hampshire	2,800	5,000
34 New Jersey	20,200	36,200
35 New Mexico	4,200	7,100
36 New York	38,000	68,200
37 North Carolina	22,400	38,900
38 North Dakota	1,900	3,300
39 Ohio	34,600	59,900
40 Oklahoma	8,200	13,700
41 Oregon	8,600	15,600
42 Pennsylvania	31,600	55,500
44 Rhode Island	2,100	3,900
45 South Carolina	11,500	20,000
46 South Dakota	2,000	3,500
47 Tennessee	17,100	29,800
48 Texas	71,500	123,400
49 Utah	5,700	10,300
50 Vermont	1,600	2,800
51 Virginia	18,500	32,100
53 Washington	16,600	29,700
54 West Virginia	3,800	6,000
55 Wisconsin	14,900	26,300
56 Wyoming	1,700	2,600
Total	**744,900**	**1,314,300**



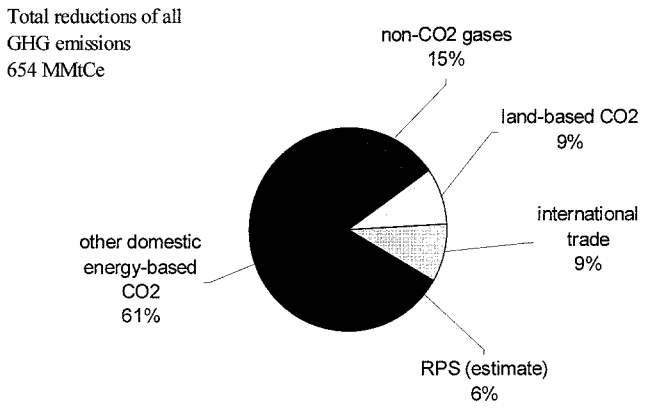
The NEMS model captures the feedback between natural gas demands and price. In the base Case natural gas prices decline sharply from current elevated levels and then rise slowly over the next twenty years. The All Demand Case reflect only the energy efficiency and CHP measures which reduce electricity demand and hence the demand for natural gas, since NGCC plants dominate the long term margin; thus natural gas prices are lower than in the Base Case. Similarly in the RPS Only Case (renewables ramping up to 20% of national generation by 2020) renewable electricity generation (largely from wind, biomass and geothermal) displaces natural gas and thus reduces its price below the Base Case. In the All Demand/Supply Case all of the demand and supply side policies are combined. The tighter emissions caps (for SO_2, NO_x, and Carbon) will cause a shift from coal to natural gas and thus by themselves would increase natural gas prices relative to the Base Case, thereby counteracting the effects of efficiency and the RPS. The All Demand/Supply case "with tax" includes the carbon auction price (or tax), but since these tax revenues are assumed to be returned the "All Demand/Supply case without tax" represents the overall impact of the full set of policies on natural gas prices. Note that it increases natural gas prices in the near term above the Base Case and decreases them below the Base Case in the longer term.


Total Electricity Generation
Base Case
Policy Case
TWh
Cogeneration
Non-Hydro Renewables
Nuclear
Natural gas
Hydropower
Oil
Coal

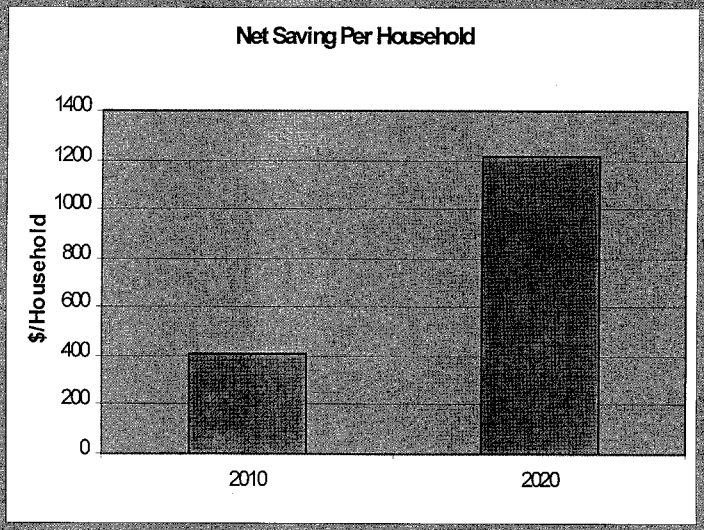

Generation by Renewables
Base Case
Policy Case
TWh
Co-firing
Co-firing
Wind
Solar Thermal
Municipal Solid Waste
Photovoltaic
Biomass
Geothermal


Local Air Pollutant Reductions
Carbon Monoxide
million tons
80
70
60
50
40
1999
2006
2013
2020
Sulfur Dioxide
thousand tons
25
20
15
10
5
0
1999
2006
2013
2020
Particulates (PM-10)
thousand tons
2.0
1.8
1.6
1.4
1.2
1.0
1999
2006
2013
2020
Nitrogen Oxides
million tons
25
20
15
10
1999
2006
2013
2020
Volatile Organic Compounds
thousand tons
10
8
6
4
2
0
1999
2006
2013
2020
Base case
Climate Protection

Carbon Reductions in 2010 to meet Kyoto Target



Annual Net Savings



Mr. OSE. Thank you, Dr. Bernow. Our next witness, and I apologize, Dr. Bernow, I did not do an adequate job of introducing you prior to your remarks. I do want to add, as evidenced by his comprehensive presentation, Dr. Bernow has a B.S. degree from Columbia University School of Engineering and Applied Science and a Ph.D. in Physics from Columbia University. Again, we thank you.

Our next witness is Mr. Byron Swift. Mr. Swift is the Environmental Law Institute's senior attorney. He is the director of ELI's Center for Energy and Innovation. He currently is spending much of his time investigating how environmental regulations affect the utility sector, particularly as it relates to the 1990 Clean Air Act. Mr. Swift, you are recognized for 5 minutes. Thank you for joining us.

Mr. SWIFT. Thank you, Congressman, and I appreciate the invitation to be here in Peabody.

I would like to preface my remarks by suggesting that the topic I would like to talk about is what Congressman Tierney has just mentioned, what is smart public policy and also a public policy that avoids some of the economic problems mentioned by Congressman Ose.

I would like to talk about how environmental regulation, while it creates the framework for the environmental reductions and environmental quality, can discourage innovation and new technology. Innovation is the motor that we want to drive lower costs and increase environmental benefits. And also how this problem can be solved by more effective and flexible regulation.

I would basically like to make two points. One is that unfortunately the way environmental laws are written has created a strong tendency to discourage innovation, especially in the process technologies and pollution prevention technologies. The way environmental laws are written tends to embody a "control and dispose" mentality that is opposed to a "recycle and renew" policy.

The second point is simply that we can design better laws that both increase innovation and environmental quality. If you can visualize a square with four quadrants and on the top are mandatory laws or policies and on the bottom are voluntary, and on the left are flexible policies, and on the right inflexible, what you tend to have are environmentalists and State environmental regulators who believe in mandatory but inflexible regulation, and a business community that wants voluntary and flexible standards. This difference stops some of the political progress toward solving this problem. What we want as a good government alternative are mandatory laws that protect public health and welfare, but flexible standards that allow businesses to comply and innovate.

I have done a considerable amount of research in various environmental sectors that illustrate some of these problems, and I would like to mention a few of them. They are contained in some of the publications that are on our Web site, Environmental Law Institute, and also those of the Progressive Policy Institute. But just to mention some of the problems, in the iron and steel sector, regulations under RCRA, which is our solid waste disposal act, regarding recycling, frustrate the ability of firms to economically recycle spent acids, which leads to the disposal or underground injection of literally hundreds of millions of gallons of acids annually.

The culprit is one sentence in RCRA. It is an exemption to the exception for recycling of hazardous wastes.

In the baking sector, another inflexible rate-based standard has forced industrial bakers to install very expensive end-of-pipe controls instead of pollution prevention technologies. And, in the energy sector, which is one of the key sectors we are looking at today, New Source Review requirements, which impose a distinction between old sources and new sources, place disproportionate burdens on the cleanest technologies, which hinder the transition to clean energy sources.

Another thing I would like to mention that I find very disturbing, and it is not given a lot of press, is the state of venture capital finance for innovation. If you care about innovation, you care about private finance for innovation. The government can take up some of the burden in research and development costs, but it is the private sector that has got to be the motor. And as we are all aware, the nineties were the technology decade. We saw funds for venture capital for technology rise from a few billion dollars in 1990 to over $40 billion this past year. In contrast, venture capital for environmental technologies started out modestly at $200 million in 1990 and has sunk every year since to virtually nothing today, $50 million. Data from Environmental Business International show that environmental mutual funds have also gone from $240 million in 1993 to zero this year.

This is a huge problem. Why isn't this funding available for environmental technologies? My discussions with the financiers, most of whom no longer exist, have suggested the lack comes about because of environmental regulation. You have a very long permitting process that very few of these innovators can survive, and you have got a balkanization of the permitting of your market into hundreds of permitting districts. Again, this doesn't have to be the case. We can design laws that don't create this permitting system or balkanize the market, but it is a very unfortunate side light to the current environmental regulatory landscape.

Finally, I would just like to say that I don't want to say that environmental regulations are always a problem. In many industries, economic factors may be a principal barrier to innovation and cleaner production, but it is inexcusable for environmental regulation to frustrate the very innovate process that we hoped it would foster, because of their inflexible design. Alternatives are available, and I and many of my colleagues hope to help by pointing out the specific problems and potential for remedies that will achieve greater innovation and a cleaner environment.

[The prepared statement of Mr. Swift follows:]

Testimony of Byron Swift,
Director, Energy and Innovation Center
Environmental Law Institute

Before the
Subcommittee on Energy Policy, Natural Resources
and Regulatory Affairs of the House Committee on Government Reform

June 17th, 2002
Peabody, Massachusetts

How Current Environmental Regulation Discourages Innovation In New Technology, and how this Problem can be Solved by More Effective, Flexible Regulation

Environmental regulation has a strong effect on technology development and use
- especially on manufacturing technologies, which must be permitted

Our environmental regulatory framework has been found to exert a strongly negative bias on the development and adoption of innovative technologies. A major problem is that the causes differ in almost any sector, but principle causes are:

- length of permitting process;
- requirement in pollution laws to only approve "available" technologies;
- balkanization of hundreds of permitting jurisdictions; and
- new source/old source distinction in clean air laws.

The unintended effect of the "command and control" type of environmental regulation has been to strongly discourage technology innovation, and to channel what innovation is permitted into wasteful end-of-pipe processes.

This can be seen in the disastrous state of venture capital funding for innovation in environmental technologies. In contrast to robust venture funding for other technology fields such as communications, health, and general industrial sectors, which rose from $7 billion in 1995 to over $40 billion in 2001,[1] private venture investment in environmental technologies declined from $200 million in 1990 to less than $60 million today according to Environmental Business International. This is a grave problem, as venture funding would be expected to be the fuel for the innovation motor.[2] Environmental mutual funds have also shrunk, from $240 million in 1993 to $62 million in 1999. Further, investment in research by the firms that develop and market environmental technologies is also at low levels, around 3 percent of revenues in the major air and water technology sectors.[3]

Two key factors that inhibit financing stem from environmental regulation - opportunity and market size. Opportunity is affected because even if a technology works and is commercially acceptable to business, government regulators must accept it in the permitting process. Time delays, lack of familiarity with the technology, and other

problems may prevent commercialization. Further, because federal environmental laws delegate most permitting authority to the states, the environmental market is fractioned into 50 state markets and hundreds of smaller ones. Approval in one state or jurisdiction is no guarantee of approval in another, creating a balkanized market—a formidable entry barrier for new environmental technologies. For these reasons, private capital has virtually left the environmental field.

Another serious problem is evident in the energy generation field, where the distinction between old and new sources under New Source Review has driven industry to devote over 90 percent of its research funding into maintaining old plants, and not developing the energy technologies of the future.[4] Because the Clean Air Act allows old plants to continue emitting pollution, but places high economic burdens on very clean new plants, it discourages investment in new plant and equipment.

Key problems with existing environmental regulations include Congress' definition of standards to dictate end-of-pipe technologies and results, and the existence of lengthy permitting processes that require government regulators to approve technology choices. What is needed instead is "command without control" – mandatory government standards that ensure the protection of public health and welfare, but regulatory systems that give businesses the freedom to experiment with and select their own technology solutions.

Solutions have been demonstrated, although they vary in every field. For the regional air pollutants generated by the power sector such as NOx, SOx and carbon, the answer is emissions cap and allowance trading systems. These create better environmental results than existing regulation at far less cost to business, and promote innovation.

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[1] PricewaterhouseCoopers, Money Tree Survey (http://www.pwcmoneytree.com).

2. Environmental Business International, unpublished data. San Diego, CA, 2000.

3. Environmental Law Institute, *Research and Development Practices in the Environmental Technology Industry* (Washington, DC: September 1997).

[4] The power industry research coalition, EPRI (formerly the Electric Power Research Institute), had a 1999 budget of $364 million, of which over 90% was devoted to improving existing plants, not developing new technologies. ELEC. POWER RESEARCH INST., ANNUAL REPORT (1999), available at www.epri.com. On the other hand, government spending is about evenly split, with half of the DOE's energy research budget devoted to developing new electricity-generating technologies. Roughly half of the DOE's $2.1 billion fiscal year 2000 appropriation for "Energy Resources" is oriented towards new power technologies and energy conservation. U.S. Dept. Of Energy, FY 2001 Budget Request To Congress (2000). We see, therefore, that our regulatory system, which imposes stringent environmental requirements on new plants but not old plants, creates major economic pressure on business to extend the life of old plants, causing the industry to mis-allocate hundreds of millions of research dollars.

Policy Report
April 2000

How Environmental Laws Can Discourage Pollution Prevention

Case Studies of Barriers to Innovation

by Byron Swift

Pollution control laws have brought us better health, cleaner water and air, and improved our quality of life. Yet, in some circumstances, these same "first generation" laws inadvertently constrain technological innovation and hinder comprehensive solutions to environmental problems. This paper highlights how some of the regulations putting these laws into practice—and at times the laws themselves—narrow technological choices, add unnecessary costs, and may fail to prevent pollution in the first place.

Using case studies of five industries, this report illustrates how these perverse outcomes may occur, even when the law or regulation on its face appears reasonable.[1] These cases also convey a positive message: new technologies, or old technologies creatively applied, can help achieve environmental goals while consuming fewer natural resources, using less energy, and preventing pollution through cleaner processes. Each of the case studies presents different barriers to innovation and a proposed solution tailored to the specific problem:

- In the baking industry, innovative technologies reduce ethanol emissions only slightly less than the technology favored by regulators, but would offer significant overall environmental advantages by using less energy and eliminating use of toxic metals, at a fraction of the cost.

- In the dry-cleaning industry, water-based cleaning and other innovative technologies could entirely eliminate the use of the hazardous solvent perchloroethylene, but are not encouraged by current regulations that focus only on control technologies.

- Nitrogen oxide emissions from power plants could be significantly reduced if old sources and new sources were not treated differently—as they are under current law—and if laws and regulations didn't offer significant advantages to selected technologies, placing the highest burdens on the cleanest technologies.

- Regulatory changes applied to the iron and steel industries would make recycling and reuse of hydrochloric and sulfuric acids more economically attractive than the current practice of disposing spent acids in landfills and underground injection.

- Curtailing mercury use in products and industrial processes would be far more effective and efficient than requiring expensive end-of-pipe controls on incinerators.

There are some who believe that environmental regulation is too stringent and should be relaxed. Others say that injecting flexibility into regulation will inevitably lead to more pollution. These case studies show that there is a Third Way to achieving better environmental results by adopting standards that are stringent in their goals, but flexible in their means of achieving those goals. Standards and regulatory approaches can be designed to continuously stimulate and reward technological innovation. Laws that "command" but not "control" would encourage the redesign of industrial processes to produce less waste, instead of relying on expensive equipment to clean up pollutants at the end of the production process.

How Some Regulations Inhibit Innovation

Environmental laws and regulations create an imperative to reduce pollution. Depending on how these laws and regulations are written, they can either drive innovation and prevent pollution, or do the opposite and freeze technological choice. Some first generation laws and regulations tend to have this chilling effect on innovation. Hence the moniker "command and control," referring to standards or methods that in practice lead regulators to mandate a specific technology to control pollution at the end of a discharge pipe or smokestack.

One of the biggest culprits inhibiting technological innovation are regulations that implement "technology-based rate standards," which are typically expressed as a concentration limit or percent reduction of a single pollutant coming out of a pipe or smokestack. Examples would be a standard that is expressed as an 80 percent reduction in end-of-the-pipe emissions, or a discharge rate of 25 micrograms per cubic meter. These standards typically begin with a mandate from Congress to the Environmental Protection Agency (EPA), requiring industries to adopt "control technologies" that are either "feasible," "best available," or "maximum achievable." These standards are poor performance benchmarks because they focus only on one pollutant and require reductions only in rates— not in amounts of overall pollutant discharges—and so will favor single-pollutant, end-of-the-pipe solutions.[2]

Strictly speaking, these kinds of rate standards are not technology mandates, but their practical application can be just as limiting for new technologies. To implement rate standards, EPA and state regulators must evaluate how much each available (i.e. existing) technology can reduce a particular pollutant and judge appropriate costs. Regulators tend to pick and then require an available technology that fits the bill. This discourages firms from taking the risk of choosing or experimenting with newer, potentially superior alternatives. Even if a source could reduce overall pollution through process changes, a rate standard may still require it to add the same end-of-the-pipe equipment anyway, discouraging a move to cleaner processes.

Rate limits have other disadvantages. First, they do not promote continuous innovation, but instead lead to one-time compliance, often through the use of the identified available technology. Second, they are inflexible: even if new process technologies are far cleaner overall, they cannot be permitted if one substance exceeds a single parameter. And finally, the permitting process can be time-consuming and adversarial: regulators can take one to two years to issue a permit, adding significantly to regulatory costs.

Second Generation Strategies Thrive on Technological Innovation

Technological choice and more comprehensive solutions are the keys to producing more environmental benefits at less cost than prescriptive, first generation regulation.[3] If we want businesses to innovate, to actively search for creative solutions to reduce pollution, and to lower the costs of environmental compliance, we must move beyond reliance on prescriptive, end of pipe rules. Second generation approaches would:

- Use standards that specify a set of desired environmental outcomes rather than end-of-pipe rate reductions in single pollutants;
- Eliminate outdated mandates in federal and state laws requiring specific technologies;
- Favor upstream pollution prevention instead of downstream pollution reduction;
- Establish emissions and effluent "cap and trade" programs; and
- Reform hazardous waste law to eliminate barriers to reuse and recycling.

Second generation tools tested in states and in a few federal programs are showing that strict environmental standards can be maintained and ultimately exceeded when regulators offer greater choice in how standards are achieved. Indeed, true performance standards can be designed to be far more efficient than the rate-based standards arising from the mind set of pollution control. For example, the sulfur dioxide emissions trading program in the Clean Air Act achieves major reductions using a cap on total emissions, eliminates permit-by-permit review of technology, and allows transactions to take less than 24 hours.[4] Further, "cap and trade" programs help commercialize emerging technologies that either fail to achieve a rate standard by a small amount, but are much cheaper; or overachieve a standard, but are more expensive. Neither has a commercial life without a trading system.

The Current Regulatory System Discourages Private Finance of New Technologies

Today, there is far less funding for environmental technology than for telecommunications, health, and general industrial sectors. Private venture capital for innovation in environmental technologies, particularly important for small technology developers, has declined precipitously from $200 million in 1990 to less than $60 million today.[5] In stark contrast, venture capital investment in the United States reached a new high of $35.6 billion in 1999.[6] Environmental mutual funds have shrunk from $240 million in 1993 to $62 million in 1999. Government funds, never plentiful, are also declining. Further, investment in research by the firms that develop and market environmental technologies is also at low levels, around 3 percent of revenues in the major air and water technology sectors.[7]

Two key factors stemming from regulation inhibit financing - opportunity and market size. Opportunity is affected because even if a technology works and is commercially acceptable to business, government regulators must accept it in the permitting process. Time delays, lack of familiarity with the technology, or other problems may prevent commercialization. Further, because federal environmental laws delegate most permitting authority to the states, the environmental market is fractioned into 50 state markets and hundreds of smaller ones, each one representing a permitting jurisdiction. Approval in one

state or jurisdiction is no guarantee of approval in another, creating a balkanized market---a formidable entry barrier for new environmental technologies. For these primary reasons, private capital has virtually left the environmental field.

The Call For Change

While current environmental laws provide us with an adequate environmental protection system, they must be reformed if we hope to develop an excellent one. Our laws need to achieve a better integration with business decision-making and promote continuous improvement, but changing the basis for regulation will not come easily. Although second generation strategies could create significant overall economic benefits, some existing firms that already have invested and adapted to the current inflexible system have a stake in preserving it, and high regulatory costs can repel new entrants and potential competitors. On the other side, some in the environmental community seem to perceive inflexible laws as stricter and somehow better, creating further resistance to change.

National and state leaders can breach these attitudes over time by encouraging further experimentation with second generation strategies that produce consistently better and more cost-effective environmental outcomes. The following case studies demonstrate how the first generation regulations can slow environmental improvement, but more importantly, point the way toward an innovation-friendly second generation of environmental action.

Case Studies

Baking

A rate standard known as a "percentage rate reduction" requires most bakers to adopt a single technology selected by government regulators, instead of allowing them to choose other technologies with lower total environmental impacts and lower costs.

Problem: Under the Clean Air Act, large bakers in urban areas must install "reasonably available control technology" (RACT) to control their emissions of ethanol, a natural byproduct of yeast fermentation. EPA defines RACT as requiring emission reductions of 80 percent to 95 percent, and has determined that catalytic oxidation is the only reasonably available technology which can achieve this level of reduction. Some innovative technologies can achieve slightly lower levels of ethanol control, yet are many times cheaper and reduce overall environmental impacts by using fewer resources and energy, and no toxic metals. One alternative could even return energy to the plant. Nonetheless, prospective purchasers of these alternative technologies have been unable to receive permits under the RACT emissions rate standard.

Barriers: An emissions rate limit standard creates several barriers to the use of innovative technologies. If regulators determine that an innovative technology is not "available," then it cannot be permitted. Those technologies which fall just short of achieving the 80 percent level cannot obtain the commercial testing, demonstration, and refinement needed to improve their performance and become "available" and commercialized. Trading between sources is prohibited (absent special state programs), even though it would facilitate the use of innovative technologies while achieving similar pollutant reductions. In

addition, EPA test methods for ethanol and other volatile organic compounds (VOC) perform poorly in water-laden airstreams like those from bakeries. This puts innovative technologies that condense ethanol into a water medium at a disadvantage. Further, all these barriers are magnified by our federal system, as vendors of innovative technologies have to overcome the same barriers repeatedly in every state.

Bottom Line: These unintended barriers created by the regulatory system create a de facto monopoly position for the catalytic oxidation technology. The environmental benefit of its higher rates of ethanol reduction is more than offset by its higher energy consumption and use of toxic metals. The solution to this problem is to replace the percentage reduction standard with a limit on the overall quantity of emissions(called a "mass-based standard"), but does not dictate technology choices. Especially if combined with a well-designed emissions trading program, this would provide an incentive to switch to more efficient and effective technologies.

Table 1: Baking

FACTOR	REGULATORS' CHOICE	ALTERNATIVES
Technology	Catalytic oxidation	Heat exchanger, wet scrubbing
Percent reduction of ethanol	80 to 95%	75-80+%
Energy savings	0%	50-90%
Use of toxic metals	High	None
Cost	—	½ to 1/3 of regulators choice
Test method	Expensive; moderate accuracy	Inexpensive; high accuracy

Dry Cleaning

For small businesses like dry cleaners, more environment-friendly alternatives are unlikely to gain a foothold in the market unless regulators change their own focus from pollution control to pollution prevention.

Problem: Fire regulations in the 1960s forced dry cleaners to switch from petroleum-based solvents to perchloroethylene (PERC), the main solvent used today by the dry cleaning industry and a hazardous air pollutant. Under the Clean Air Act, dry cleaners have been required to reduce emissions of PERC, and while regulation has led to gradually lower emissions, it has not prompted the industry over four decades to adopt cleaner technologies. Several innovative technologies using water, liquid carbon dioxide (CO_2), and ultrasound have all been shown to be as effective as PERC in cleaning garments and would do away altogether with the need for PERC. This shift is not only environmentally preferable, but would eliminate disposal costs and business risks of using toxic materials in urban areas.

Barriers: Regulation focused on end-of-pipe results has done little to eliminate the root environmental problem or stimulate technological transformation in this highly dispersed industry. Regulation is not the only barrier to innovation. Because the industry is so fragmented—with over 30,000 independent small businesses—it is difficult to raise funds for research, experimentation, and risk-taking. Similar to other environmental technology areas, external sources of funds such as private venture capital or

government funding are scarce. The only significant private effort to launch a new process uses liquid CO_2, and originated outside the industry in a large technology company. Another major barrier is the "dry clean only" consumer labeling standard developed long before current technologies. The labeling standard imposes a risk of liability on "dry cleaners" using water as the cleaning agent, and inhibits them from using available and demonstrated innovative water-based cleaning technologies.

Bottom Line: Regulation of the dry cleaning industry has simply tightened discharge rates and emission limits. The industry has responded, not by preventing the pollution in the first place, but by modifying its equipment to provide greater and greater end-of-pipe control and treatment of hazardous air emissions. A broader regulatory focus, coupled with more investment funds and vision in this small-business industry, has the potential to stimulate industry research and adoption of alternative processes which avoid pollution altogether.

Table 2: Dry Cleaning

FACTOR	REGULATORS' CHOICE	ALTERNATIVES
Technology	Reduction of perchloroethylene (PERC) emissions	Water technologies; liquid carbon dioxide/dry wash; ultrasound
Reduction of PERC use	0%	100%
Reduction of PERC emissions	80-95%	100% from complete elimination
Hazardous chemical disposal costs	High	0 from complete elimination

Nitrogen Oxides from Electric Power Generation

Reducing nitrogen oxide (NOx) emissions from power plants to control urban ozone is hampered by two major regulatory flaws: differential treatment of old and new sources, and differential treatment of technologies—with the greatest burden placed on the cleanest technologies.

Problem: Regulations under the Clean Air Act are technology-based rate standards that exempt or impose lenient standards on existing plants, and impose strict standards and more costly reductions on efficient new sources. As a consequence, they perpetuate the life of old, highly polluting plants and actively discourage the introduction of the newer technologies that would simultaneously lower NOx emissions and other pollutants from older coal-fired plants. The result is both higher costs and dirtier air. Large and relatively inexpensive NOx reductions could be achieved with alternative regulatory approaches and technologies.

Barriers: The rate-based standards for NOx require government regulators to establish different rates for each type of power technology based on known pollution control technologies. Such standards fail to provide any incentives to move from dirty to clean technologies, the essential step needed to reduce pollutant emissions from the power sector. The process also often fails to anticipate innovation in compliance technologies that could occur, creating inefficiency. Ironically, for existing plants, the resulting standards place the least requirements on the highest emitters, cyclone coal boilers. The most efficient new sources— combined cycle gas plants with cogeneration—have the highest regulatory burden, and get no regulatory credit for their superior efficiency. Finally, some states require plant owners to install end-of-pipe controls such as selective catalytic reduction to even the cleanest modern

gas technologies. These controls can increase emissions of ammonia and other pollutants more than they reduce NOx. These factors inhibit wider use in the market of new gas-fired power sources which emit far lower NOx than existing coal-fired plants, and virtually none of the other major pollutants from coal combustion.

Bottom Line: The best solution to these problems would be for EPA and the states to implement an overall NOx emissions cap and allowance trading system that levels the playing field between old and new sources. This method sets a strict limit on total allowable NOx emissions, but allows great flexibility in choice of technology to yield the lowest-cost reductions. An emissions cap and trading system promotes alternative methods, including a switch to cleaner fuels and processes, as well as end-of-pipe controls. This could achieve more pollution control at a lower cost than any form of rate standards. Alternatively, a less bold but still positive step would be to change the current rate standards to output-based standards that rewarded energy produced efficiently with the least pollution.

Table 3: Nitrogen Oxides from Electric Power Generation

FACTOR	REGULATORS' CHOICE: RATE STANDARDS	ALTERNATIVE: CAP AND TRADE
Technology promoted	End-of-pipe (especially selective catalytic reduction)	Various (including switching to gas-fired combined cycle turbines)
NOx emissions reductions	High	High
Other pollutant emissions reductions (SO_2, toxics, CO_2)	0%	60-100%
Reward for efficiency	None (moderate, if output-based)	High
Regulatory exemption ("grandfathering") for old plants	Yes (results in higher emissions)	No
Compliance costs	High	Medium to high
Transaction costs	High	Low

Iron and Steel

Toxic wastes should be safely disposed, but current law carries this concept to extremes and inadvertently discourages adoption of clean production practices. By emphasizing a "cradle to grave" approach to hazardous wastes, the Resource Conservation and Recovery Act (RCRA) precludes a more sustainable "cradle to cradle" recycling system, and in effect creates waste from material which could otherwise be reused.

Problem: A major pollution problem of the iron and steel industry is the discharge of spent sulfuric, hydrochloric, or mixed acids used to form finished steel. Each year approximately 1.4 billion gallons

of spent hydrochloric and sulphuric acids are discharged, primarily to receiving waters, landfills, or injected underground. EPA estimates that only 2 percent are reclaimed and recycled.

Barriers: The most immediate barrier to lowering discharges of acids used in the production process is the definition of solid waste in EPA's RCRA regulations, in which used acids must be treated as a RCRA waste if they are to be reclaimed. This requires a firm to apply for a RCRA storage permit, which is difficult and costly to obtain, and adds significant paperwork if the firm wishes to reuse the material in the production process. These requirements escalate the difficulty and cost of recycling so much that it is more economic for most firms to dispose of the acids instead. Economic barriers also affect the recycling of spent acids, including fluctuating prices paid for the reclaimed byproduct ferric chloride, the cost of transport, and low competing prices for landfilling and underground injection of acids. Another barrier to eliminating these wastes altogether is the lack of industry efforts to research and develop cleaner technologies and non-toxic alternatives to the use of these acids.
Bottom Line: EPA should amend the definition of waste to allow reclamation activities to proceed without having the material become a RCRA waste.[8] In addition to removing this regulatory barrier, EPA and the states could alter the economic equation by imposing fees that would make disposal of acids through discharge or underground injection more expensive than reclamation and re-use.

Table 4: Iron and Steel

FACTOR	REGULATORS' CHOICE	ALTERNATIVE
Technology	Disposal of spent acids as RCRA wastes	Reclamation and re-use of spent acids
Materials reduction	None	Major reduction in chemicals to make new acids
Percent of used acids recycled	2%	High
Waste reduction	Low	High
Operational cost savings	None	Medium

Mercury Reduction

Reducing intentional uses of mercury in products and industrial processes would be a more efficient and effective means of reducing mercury in the environment than regulating emissions from incinerators that burn wastes with mercury-containing products.

Problem: The intentional use of mercury in products and processes results in more than half of mercury releases to the environment (the remainder is released unintentionally, mostly from burning coal). These releases include direct discharges from leakage and product breakage, transfers to landfills (including incinerator ash) where the mercury may potentially remain for long periods of time, and direct air emissions if wastes are incinerated. Current regulation to control mercury pollution derived from intentional uses, however, focuses on air emissions from waste incinerators. This approach is expensive and fails to address major releases through product breakage, leakage, and disposal.

Barriers: Regulation of waste incinerators imposes costs of $500-$3,000 per pound of mercury reduced, and does not provide any incentives for pollution prevention, as waste incinerators are not responsible for the mercury use in the first place. Additionally, these end-of-pipe controls simply capture and transfer the mercury to liquid or solid wastes, where some re- release of mercury to the environment is likely over time. In contrast, under a prevention approach, reductions would be permanent by reducing the use of mercury in products and processes. This approach has been used in laws that eliminated the use of mercury in paints and most batteries, and in voluntary programs for mercury reductions undertaken by some industries.9 However, EPA lacks comprehensive authority to pursue a prevention approach under the strict, control-oriented Clean Air Act regulations for air toxics.10 The price of mercury is currently below $3 a pound, less than 1 percent of the cost of controlling mercury from incinerators. This indicates that reductions in use through product substitution may be far more cost-effective than the high costs of controls on incinerators, although this may vary among individual products and uses.

Bottom Line: Regulation should focus upstream on users not emitters of mercury, who can make prevention decisions. The current uses of mercury principally in older chlor-alkali plants (160 tons), wiring (57 tons), dentistry (40 tons), lamps (29 tons), and measurement instruments (24 tons) are typically not essential, and substitutes are available for most products. Although some recycling programs exist, these capture only a small percentage of the mercury used. The Administration and Congress should work together to adopt legislation that requires source reductions of mercury by all intentional users, taking into account overall environmental gains from reductions in mercury use as well as voluntary recycling programs. This could be implemented by requiring reductions on a sectoral basis, or preferably by placing an overall and declining cap on the amount of mercury that could be sold annually. This approach would achieve dramatically greater reductions in total mercury releases, reduce the problems of re-release of mercury, and cost substantially less than the current emissions abatement approach.

Table 5: Mercury Reduction

FACTOR	REGULATORS' CHOICE	ALTERNATIVES
Technology	Emissions reductions	Source reduction
Environmental effectiveness	Low (transferred to other media)	Total and permanent
Waste reduction	None (significant wastes)	100 % elimination
Operational cost savings	High ($500-$5400/lb) and continuing	Low (some at $3/lb) and one-time

Byron Swift is senior attorney and director of the Energy and Innovation Center at the Environmental Law Institute in Washington, DC, (swift@eli.org). ***The author wishes to thank Debra Knopman, director of the Progressive Policy Institute's (PPI) Center for Innovation & the Environment, for her assistance in the***

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For further information about the Center for Innovation & the Environment or other PPI publications, please call the publications department at 202-547-0001 or write: Progressive Policy Institute, 600 Pennsylvania Avenue SE, Suite 400, Washington, DC 20003, or visit PPI's site on the World Wide Web at: ***http://www.dlcpswiftpi.org/enviro.html-ssi.***

Endnotes

1. This paper draws from research supported by The Joyce Foundation and described in: Environmental Law Institute, *Barriers to Environmental Technology Innovation and Use*, (Washington, DC: Environmental Law Institute, January 1998).

2. Many observers have noted how rate-based standards inhibit technological innovation. For example, a blue-ribbon panel convened by the U.S. EPA concluded: "Specifically, policy makers should reconsider the way 'best available technology'-based regulations are now developed and applied. Such regulations use agency established technology-based limits and use a technology to demonstrate that the limits are achievable." Even though these are performance-based requirements, they have a strong tendency to lock in the technology that is used to demonstrate achievability. To some extent, reliance on 'best available technology'-based regulations impedes the development and introduction of innovative technologies." U.S. Environmental Protection Agency, *Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation*, at 39 (EPA 101/N-91/001, January 1991).

3. For discussions of second generation approaches, see for example Debra S. Knopman and Emily Fleshner, *Second Generation of Environmental Stewardship: Improve Environmental Results and Broaden Civic Engagement*, (Washington, DC: Progressive Policy Institute Policy Briefing, May 1999); National Academy of Public Administration (NAPA), *Setting Priorities, Getting Results: A New Direction for EPA*, (Washington, DC: NAPA, April 1995); NAPA, *Resolving the Paradox of Environmental Protection: A New Direction for EPA*, (Washington, DC; Aspen Institute, 1997), *The Alternative Path: A Cleaner, Cheaper Way to Protect and Enhance the Environment*, (Aspen, Colorado; Center for Strategic and International Studies, Enterprise for the Environment, 1996), *The Environmental Protection System in Transition: Toward a More Desirable Future*, (Washington, DC, 1998); Marian Chertow and Daniel Esty (eds.), *Thinking Ecologically: The Next Generation of Environmental Policy*, (New Haven, Yale University, 1997); President's Council for Sustainable Development, *Sustainable America*, (Washington, DC, 1996).

4. Ellerman, Denny *et al.*, Markets for Clean Air (in press); Burtraw, Dallas & Byron Swift, *A New Standard of Performance: An Analysis of the Clean Air Act's Acid Rain Program*. 26 Environmental Law Reporter 10411 (August, 1996).

5. Environmental Business International, unpublished data. San Diego, CA, 2000.

6. PricewaterhouseCoopers, 1999 Money Tree Survey (http://www.pwcmoneytree.com).

7. Environmental Law Institute, *Research and Development Practices in the Environmental Technology Industry* (Washington, DC: September 1997).

8. EPA's regulations provide: "(c) Materials are solid wastes if they are recycled or accumulated, stored, or treated before recycling...." There is an exemption to the RCRA definition for recycled material which is returned to an industrial process, but it does not apply whenever the material is reclaimed during this process. 40 CFR 261.2(e) (1996). Spent materials, such as pickle liquor, are specifically stated to be solid wastes when reclaimed. 40 CFR 261.2(c)(3). EPA actively considered a change to these regulations in the late 1990s, to allow either reuse within a plant or among a broader network of users, but this initiative failed due to resistance within EPA and in the environmental community. Some environmentalists fail to see the problem caused by the restrictiveness of the current regulation, and erroneously believe that the greater the extent to which RCRA applies to materials, the more the environment is protected.

Mr. OSE. Thank you, Mr. Swift. We appreciate your being here today.

Our next witness is Dr. David Fairman. Dr. Fairman received his Ph.D. in political science from MIT in 1998. He has also held research appointments at MIT in various positions, including the Center for International Studies. He has been at the Harvard Law School Program on Negotiation and at the Harvard Center for International Affairs, and he has also taught a graduate course at MIT's Department of Urban Studies and Planning. Dr. Fairman graduated summa cum laude with a B.A. in history and literature from the UC Berkeley of the East, that being Harvard College, in 1987. Dr. Fairman, welcome. Thank you for joining us.

Mr. FAIRMAN. Thank you, Chairman Ose, and let me just say grade inflation had hit the Berkeley of the East at that time. [Laughter.]

Chairman Ose and Congressman Tierney, thank you very much for the opportunity to testify here in regard to the important issue of national energy policy. My organization, the Consensus Building Institute, does not specialize in energy policy, we specialize in helping build consensus to resolve conflicts on public policy issues. Recently, we had the opportunity, in collaboration with Rocky Mountain Institute, to facilitate a process of expert consensus building on questions related to national energy policy. Most of the experts who participated in our exercise, called the National Energy Policy Initiative, are senior people who have served in both Republican and Democratic administrations, in the private sector and academe. Several are currently in the private sector, having recently left public office. You have in the report itself a list of the 22 participating experts and 12 who joined subsequently and their consensus. And, I want to speak briefly to what they reached consensus on.

Remarkably, given the diversity of the group and the complexity of the issues, the participating experts were able to reach consensus on a diagnosis of major shortcomings in our current energy policies, a long-term vision for energy policy, a set of top policy priorities and policy strategies for each of those priority areas. The text of those recommendations is in the National Energy Policy Initiative Expert Group Report, which I understand is going to become part of the record of this hearing. The text is theirs; that is, it is a consensus document, the words themselves were co-drafted by the group. And I want to just take a couple of minutes to summarize briefly the major findings of that report.

First, just very briefly, by way of background, why did we and Rocky Mountain Institute jointly undertake this initiative? Primarily because we thought that in national energy policymaking there are many opportunities for joint gains in the area of economic, environmental, and national security goals and that too often the political process, because it tends to focus on the short-term costs of change, leads to suboptimal outcomes for society. We thought that by bringing together a group of experts who are not currently quite in the thick of the political process but who have collectively a great deal of experience with it, as well as with the technical side of energy issues, we might help identify some points

of common ground that could support policymaking in the Congress and the administration.

With that, I just want to highlight the main points from the report, and I want to start by reading the vision statement that the experts agreed on, because I think it is a powerful statement of a shared sense of urgency for change. The statement reads that "The United States and the world must begin a decades-long transition to an energy system that will not run out, cannot be cutoff, supports a vibrant economy, and safeguards our health and environment. Today's patterns of energy production and consumption will not deliver these benefits to our children and grandchildren. The way we produce and use energy wastes money, threatens our environment, raises our vulnerability to accident, terrorism and economic shocks, and contributes to instability around the globe.

We must create a new energy system that makes our country and the world more secure. It must be less susceptible to major disruptions and must meet the needs of people today and of generations to come, providing adequate, affordable, and healthful energy services for all forever. The opportunity to create this new energy future is here and now. New technologies that only a few years ago seemed visionary now provide energy services to millions and demonstrate that this energy future is not only possible, but also commercially viable. The sooner we begin to act on key energy policy issues, the more control we will have over our energy future. The longer we wait, the higher the cost of action and the less certain its success.

The opportunity and the need for energy policy change are greatest in four areas: transportation and mobility, electricity services, energy security, and climate change. Redirection of government energy research, development and demonstration programs, and procurement practices is also needed to support policy change in these four critical areas."

Let me just say parenthetically that much of the presentation that you just saw from Dr. Bernow illustrates some of the core concepts that this Expert Group reached consensus on, the notion that transition is feasible if it begins early and is thoughtfully balanced among a range of strategies, but that the longer we wait the more costly it will be.

Let me speak very briefly to some of the specific recommendations in each area, starting with a short statement of the problem and then focusing on areas to work on for policy solutions. For transportation and mobility, the high oil dependence of that sector has been referenced before and the fact that fossil fuel emissions contribute to local and global environmental problems, more broadly that the transportation systems and infrastructure that we have now contribute to urban sprawl and general reduction in quality of life.

The primary focus of recommendations in this sector was on reducing oil dependence in three ways: increasing fuel efficiency through a combination of CAFE standards, gas taxes, tradeable fuel efficiency credits and/or an efficiency feebate system, promoting non-petroleum fueled automobiles, and incentivizing and supporting urban planning and transport systems to minimize sprawl.

Turning to electricity services, Chairman Ose has already mentioned some of the very serious problems that the old infrastructure and set of policies have created. The Expert Group focused on restructuring the current regulated monopoly system to encourage competition—I have more to say about that if you would like to explore that further in questions—to encourage new technologies and innovations while retaining and maintaining environmental protection. What Mr. Swift spoke to in terms of flexible environmental regulations is very much in the spirit of what this group recommended. And, finally, a little more specifically, a focus on allowing combined heat and power and distributed generation and efficiency investments; that is, allowing investments in efficiency distributed generation and CHP to receive the same rate of return as investments in new power plant generation structures.

Very briefly, with regard to energy security, the Expert Group came back to the issue of oil dependence and the transportation sector and spoke to the need for improvements in the infrastructure of our energy systems, especially energy plants, transmission and distribution lines that are vulnerable to both accidental and planned disruption.

Finally, on climate change, the experts agreed with the statements that have been made through the Intergovernmental Panel on Climate Change and also recently echoed in the report to the United States that indeed greenhouse gas emissions are a problem that increase the risk of climate change and could have significant negative impacts on the United States. And the primary emphasis that the Expert Group had in the area of solutions was to come up with a single economy-wide instrument, either a carbon tax or a tradeable permit system, that would send appropriate signals for efficient investment early, and they emphasized the need for early action, as Dr. Bernow did, in order to maximize the cost savings available. I can say a little bit more about what the Expert Group recommended on procurement and RD&D as well, if you would like. Thank you.

[The prepared statement of Mr. Fairman follows:]

House Government Reform Committee
Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs
Energy: Maximizing Resources; Meeting our Needs; Retaining Jobs
Field Hearing, Peabody, Massachusetts, June 17, 2002

Testimony of David Fairman, Ph.D.
Vice President, Consensus Building Institute
Associate Director, MIT-Harvard Public Disputes Program
Cambridge, Massachusetts

The National Energy Policy Initiative: An Expert Consensus on Long-term Goals and Strategies for National Energy Policy

Chairman Ose and Congressman Tierney, thank you for the opportunity to testify before the subcommittee on the important issue of national energy policy. Recently, my organization, the Consensus Building Institute, in collaboration with the Rocky Mountain Institute, facilitated the National Energy Policy Initiative, a process designed to build consensus on national energy policy among a diverse group of distinguished energy experts. Most of the experts who participated have served in multiple senior positions in government, the private sector and academe. Several have served in senior policy making positions in both Republican and Democratic administrations. Remarkably, given the diversity of the group and the complexity of the issues, the participating experts were able to reach consensus on

- a diagnosis of major shortcomings in our current energy policies;
- a long-term vision for energy policy;
- a set of top priority areas for policy action;
- policy strategies for each priority area.

Their points of consensus are presented in the National Energy Policy Initiative Expert Group Report. The text of this report was drafted jointly by the participating Experts—its words are theirs.

I understand that the text of the Report will be incorporated as part of the record of this hearing. Today, I will speak briefly about why we undertook the National Energy Policy (NEP) Initiative. Then, speaking primarily on behalf of the Expert Group (and without claiming expertise for myself or my organization) I will highlight the main points of the Report.

The NEP Initiative's focus on building a broad expert consensus is a response to the past three decades of experience in national energy policy making. Whether crisis-driven or incremental, the political process has tended to focus on trade-offs among strongly held interests and values (for example, choosing between increasing domestic production of fossil fuels and protecting the environment). It generally has not taken full advantage of opportunities to achieve simultaneous gains in economic efficiency, environmental protection and national security. This is particularly frustrating because energy policy offers so many opportunities for joint gains through technological innovation and through linkages to other sectors (such as transportation, construction and information technology).

The NEP Initiative's goal was to use the Administration and Congressional interest in comprehensive energy policy legislation, and our shared sense of urgency about national energy policy post-September 11th as a starting point for a focused exploration of key policy issues. The Initiative was designed to complement the political process as an informal, non-attribution forum for a distinguished and diverse group of energy experts. During the Expert Workshop, participants explored issues and created new options that could form the basis for a bipartisan political consensus.

With that as background, let me briefly highlight the key points of consensus that emerged from the Workshop, beginning with the Experts' vision statement:

> The United States, and the world, must begin a decades-long transition to an energy system that will not run out, cannot be cut off, supports a vibrant economy, and safeguards our health and environment. Today's patterns of energy production and consumption will not deliver these benefits for our children and grandchildren. The way we produce and use energy wastes money, threatens our environment, raises our vulnerability to accident, terrorism and economic shocks, and contributes to instability around the globe.
>
> We must create a new energy system that makes our country and the world more secure. It must be less susceptible to major disruptions and must meet the needs of people today and of generations to come—providing adequate, affordable, and healthful energy services, for all, forever.
>
> The opportunity to create this new energy future is here and now. New technologies that only a few years ago seemed visionary now provide energy services to millions and demonstrate that this energy future is not only possible but also commercially viable. The sooner we begin to act on key energy policy issues, the more control we will have over our energy future. The longer we wait, the higher the cost of action and the less certain its success.
>
> The opportunity and the need for energy policy change are greatest in four areas:
>
> 1) transportation and mobility;
> 2) electricity services;
> 3) energy security;
> 4) climate change.
>
> Redirection of government energy research, development and demonstration (RD&D) programs and procurement practices is also needed to support policy change in these four critical areas.

In crafting this statement, the experts knew that they were advocating very significant departures from the status quo in energy policy. They wanted to dramatize their shared sense that our current mix of energy supply sources; our current electricity and transportation infrastructures, technologies and policies; and our strategy for dealing with climate change are not sustainable. They also wanted to underscore the feasibility of achieving joint gains in economic efficiency, environmental protection and national security through policy reforms ranging from Federal R&D

through procurement to regulations and market incentives for energy production, distribution and end use.

With regard to transportation and mobility, the Expert Group noted that American transportation is now 97 percent oil-dependent, that fossil fuel emissions contribute to local and global environmental problems, and that our current transportation planning systems too often contribute to urban sprawl. The Experts recommend that we substantially reduce oil dependence, improve environmental quality and land use through three primary strategies:

1. Increase fuel efficiency through higher CAFÉ standards, gasoline taxes, tradeable fuel efficiency credits and/or an efficiency feebate system for old vehicle scrappage and new vehicle purchase;
2. promote the development of non-petroleum fueled automobiles, using technologies such as hydrogen fuel cells, through a combination of Federal RD&D and procurement, automobile industry and consumer incentive programs;
3. incentivize and support urban planning and transportation systems that minimize sprawl and make mass transit attractive to commuters.

In the electricity services sector, the Expert Group noted that our current system is hindered by highly centralized generation, costly grids, poorly regulated monopolies and command and control environmental regulation. Despite efforts at reform, perverse incentives remain in place, favoring new plant construction over investment in efficiency; continued operation of existing "dirty" plants over new investments; and continuing dominance of large centralized utilities over distributed generation, with risk to the reliability and resilience of the grid.

The Experts recommend three primary strategies to increase energy efficiency and system resilience, and reduce environmental impacts while maintaining universal access.

1. Restructure the current regulated monopoly system with appropriate rules to encourage competition. Specific options include opening wholesale generation markets fully to competitive bidding; ensuring that investments in generation and transmission efficiency earn the same return per kilowatt saved as investments in new power production; and instituting real time pricing with two-way metering.

2. Encourage adoption of new technologies and innovations while maintaining environmental protection. Rather than specifying pollution control technologies, environmental regulators should set environmental performance targets. Regulations should be structured to put end-use efficiency on an equal footing with low-/zero-emissions technologies.

3. Allow distributed power, combined heat and power, renewable technologies and demand-side investments to compete fairly with traditional power generation and delivery systems. For example, institute a national standard for interconnecting distributed generators to the grid.

The Experts also reached consensus on principles to guide future decisions about nuclear power; I would be glad to discuss these if members of the Subcommittee are interested.

With regard to energy security, the Experts highlighted the fundamental issues of oil dependence and infrastructure vulnerability. They agreed that the U.S. cannot significantly reduce its oil

dependence or its vulnerability to global price shocks through increased domestic oil production, because that production cannot meet more than a fraction of our current domestic demand, and prices are set in global, not national markets. They also noted that U.S. energy infrastructure, particularly power generating stations, transmission lines and pipelines, is vulnerable to both accidental and deliberate disruption.

To reduce oil dependence, they recommend a primary focus on the transportation sector, because the transportation sector accounts for the majority of domestic oil use. In the short term, they recommend increasing transportation fuel efficiency. In the longer term, they recommend transitioning to non-petroleum fueled vehicles, with options including hydrogen- and cellulosic biomass fuels. In addition, they recommend that the U.S. explore options for increasing participation of key allies and trading partners in a joint strategic oil reserve.

To reduce the vulnerability of energy infrastructure, they recommend detailed risk assessment of major infrastructure elements in the short term, and implementation of additional security measures where necessary. In the longer term, they recommend promoting distributed generation to reduce the concentration of generation and transmission facilities.

On climate change, the Experts agreed that greenhouse gas emissions from fossil fuel use are increasing the risk of climate change. Climate change could impose direct economic costs on the United States, and could also create global economic and political instability. However, they also agreed that making a gradual transition away from fossil fuels could be a net benefit to the economy, because investments in fuel efficiency and new non-fossil fuel technologies can be profitable if policies rely primarily on market-based instruments to drive the transition.

To deal more effectively with climate change, the Experts recommend starting immediately to send clear policy signals to producers and consumers to reduce carbon emissions. Those policies need to establish the framework for a smooth and fair transition to a more efficient, diversified, and low-carbon energy system.

Among policy options, either a cap-and-trade system or a carbon tax could efficiently internalize carbon costs across the whole economy, and could be made revenue-neutral, fair, and economically stimulative. To maximize the economic and environmental benefits of action, it will also be necessary to remove barriers to efficient energy use.

Finally and briefly, the Experts noted that Federal RD&D and procurement policies can facilitate the transitions they advocate in transportation, electric services, energy security and climate protection. I would be glad to speak further about the Experts' views on these issues if Subcommittee members are interested.

Thank you for the opportunity to testify before the Subcommittee. I will be glad to answer questions about the NEP Initiative and the Expert Group's Report.

Mr. OSE. Thank you, Dr. Fairman. Our next witness to join us is George Sterzinger. He is the executive director of the Renewable Energy Policy Project. I believe you are based on Washington, are you not? Mr. Sterzinger is responsible for REPP's day-to-day operations. He has many years service in the area of energy policy and regulation. He has worked in Nevada and various other States. He has worked with a number of energy merchants to try and develop projects for photovoltaic production, am I right?

I do want to welcome you, and we look forward to your testimony. You are recognized for 5 minutes. You need to turn that on. Push the little green button. There you go.

Mr. STERZINGER. Thank you very much, Chairman Ose and Congressman Tierney. Since it often takes me more than 5 minutes to get my audio visual equipment up and running, I thought I would just summarize the written comments and testimony that you have.

I would like to do four things today. One is to describe, in general terms, part of the work that the Renewable Energy Policy Project has been undertaking, specifically to try to capture the job benefits and the economic development potential that flow from renewable development. The second is to describe what I see as the sort of long view of the energy, and particularly the electric sector, in the United States, what it looks like 20 years out and what the function of renewable energy can be in that picture. Third, to talk about some of the roadblocks to renewables that could and will prevent their being developed unless they are addressed. And then the fourth and final thing is to return a little bit to the work of the Renewable Energy Policy Project that we have been doing in the State of Nevada.

So let me go back to the first. The Renewable Energy Policy Project works on a number of different issues related to renewable energy. We have just finished a study for the six Southeastern States on how they could fashion a clean and affordable energy future. But another thing that we have a strong commitment to is to systematically develop a very transparent and understandable tool that people can use to understand precisely what the job benefits will be from renewable energy development.

Renewable energy is composed of a number of different technologies. Geothermal, biomass, photovoltaic, solar thermal and wind are the major ones. Each one of those different technologies have different job requirements, job opportunities, and skill requirements. What we have set out to do is start with a survey of the industries that are currently working in those areas to find out exactly what kind of jobs are involved in putting up a megawatt of wind, or in putting up a megawatt of photovoltaics, or in putting up a megawatt of biomass or whatever.

We think that is a very useful tool because, to be quite honest, I think one of the great benefits of renewable energy is that it is modular and somewhat local so that ideally provided with the right tools a renewable energy development effort in a State or a locality could be seen in much the same way that any other economic development initiative was seen. It is going to provide a certain number of jobs; what can we do to capture those jobs; how can we bring as many of those benefits as possible to our State?

So we first did—we started this work under a couple of foundation-supported grants, and we went out and basically did an initial survey of some of the technologies, solar and wind in particular, and looked at everything from the manufacturing levels of jobs through the installation to the operations and maintenance in order to get a very simple but hopefully non-controversial number about what people could expect. We then put that into a very straightforward and hopefully also equally transparent economic model so that someone could see—and we used this in the State of Nevada, which I will get to at the end—someone could see if 100 megawatts were going to come in or 260 megawatts of wind were to come in, just to pick a number. You could see what to expect all the way from the beginning manufacturing process through the installation and through operations and maintenance. That model is available. We have made it available on our Web site. We have made it available to a number of other groups that are using it in specific communities that are considering doing solar in particular in order to show them in a very straightforward way what they could expect.

We intend to continue to pursue that work. We would like to do it for all renewable technologies. We would like to update it on a regular basis, and we would like to make it available on a very sort of as frictionless or as easily accessible manner as possible. I think, again, it is very important that become part of the transition in seeing renewables go from something somewhat esoteric and very hard to comprehend to something that can be understood, much like locating automobile manufacturing or any other substantial economic activity would be in a State or locality.

Let me switch now to a view of what the future looks like as a whole. I think one of the most fascinating pictures of the future is actually provided by the Energy Information Administration, which recently did an analysis of, among other things, the 10 percent renewable portfolio standard in a series of Senate bills. And what this study found I think is illuminating for a number of reasons. In part, it is the Administration—it is sort of a neutral voice or at least a somewhat neutral voice in analyzing these legislative proposals. And what it found when it looked at the business as usual unfolding of the energy system in the United States versus the 10 percent renewable portfolio standard was that moving to a 10 percent portfolio standard would lower the Nation's energy bills by 2020 by $15 billion a year.

And it found this, I think, for a very interesting reason. Right now the United States uses about 24.5 trillion cubic feet of natural gas a year. That is for all uses—for industrial processes, for electric generation, for residential and commercial burner tip uses. When you look at the business-as-usual scenario, the increase in the natural gas goes from about 24.5 to 30 trillion cubic feet a year. That figure cannot be met by domestic production. It has to be met by additional imports. Those imports, in part, will come from Canada, but a substantial portion of them will come from liquified natural gas coming into the United States on tankers from Algeria and a variety of other places.

When you go to the 10 percent renewable portfolio standard in this analysis—and I should add the Energy Information Adminis-

tration's analyses are famously conservative with respect to the renewable technologies. I mean they themselves will admit—I mean I talk with them all the time, they admit that they are dealing with old characterizations of the technology with old resource maps and so on and so forth. Putting that aside, when you look at what a 10-percent portfolio standard would do, it reduces the use of natural gas, it reduces the reliance on these imports of LNG, it lowers the price of natural gas for all users of natural gas in the United States, industrial, commercial, and electrical as well, and reduces the energy bills by $15 billion.

There are a number of ways of looking at the future of renewable energy, but that to me is very telling. I mean that shows, I think, that the technologies have reached a point where they are very serious contenders over the long run with fossil imports, especially of natural gas, in providing the electrical needs of the country.

If that is the case, why are we here talking about it? Why won't it simply happen? I mean if that is what is going to unfold, if that is really the least expensive option? I think there are a number of reasons for that, and I want to just flag them. I have three major categories of reasons that operate against what would otherwise, I think, be recognized as cost-effective renewable resources. They have to do with the financing, they have to do with sporadic nature of support, and they have to do with what I call regulatory details. As a Nation, as a whole, we have moved to a deregulated wholesale market, which basically relies on merchant plant financing for new generation.

You have graphs from the Energy Information Administration in front of you. One of the most fascinating Energy Information Administration graphs that I have ever seen is a graph of the price of natural gas from 1930 to 2002. From 1930 to 1979, it was virtually flat. From 1979 to 2002, it can only be described as undertaking some of the most fantastic jumps and unplottable movements that anyone would ever hope to see. Nevertheless, merchant plants for natural gas can receive financing. The technology is relatively known, natural gas combined cycle plants.

There are often in place regulatory mechanisms to allow the recovery of price fluctuations in natural gas that you don't see with respect to renewables. So there have been—all of the wholesale plants that have been developed in the last 3 or 4 years, the natural gas plants, have received merchant plant financing. Renewables have not been able to break through that merchant plant barrier. They are perceived as having too much risk, they are perceived as not having the kind of cost recovery protection that natural gas has. That in itself is a significant barrier.

Sporadic support for renewables. The investment tax credit has been on again/off again. If you look at the wind industry, the sort of installations, non-installations, the development of projects, the non-development of projects, has really hurt the development. If you look at where most of the wind turbine machines are coming from now, they are coming from offshore—Denmark, Japan, and other places. If you look at the industry itself, you find that people are hired; there is a fantastic run-up to put projects in place, the construction project is inefficient as a result, the next year the tax credits may end, the industry drops, the number of installations

drop, people leave the industry. So there is no systematic support, no long-term known support for the industry. It prevents an orderly regulated development.

Let me quickly go through some regulatory details. I think when you look at something as seemingly remote as the reserve requirements of a power pool or a power exchange, what you find is that as a result of developments over the last 20 or 25 years, the reserve requirements will systematically favor large plants. In New England—and I was a commissioner in the Kunin administration for the latter part of the eighties and early nineties and had firsthand taste of this—the reserve requirements are based, in part, on the largest plant on the system. If that plant goes out, the reserve requirements have to cover it.

Those reserve requirements are a social cost. Even if you don't own a piece of that plant, even if you never get an electron from that plant, if you are in that power pool, you pay that cost. When you go to renewable resources, a lot of them are perceived as intermittent, which means they are probablistic. They come on at times, they go off at times. But the probabilities of those resources are relatively well-known. And yet, the reserve requirements for those projects are often extreme. I mean oftentimes, in many parts of the country, a wind project will receive no capacity credit. If you are a purchaser of that power and you want to have that credited as firm, you have to go out and buy megawatt for megawatt, kilowatt for kilowatt capacity reserves to cover that. It is a very expensive cost penalty.

I would submit that there is as much reason now, in the interest of the environmental profile with the electric generating sector and the security interests alone, reason to consider reforming the reserve requirements to take something, let us say, the spinning reserves, which are machines that are kept running on an ongoing basis so that they are ready to come online, using spinning reserves to cover the intermittency of renewable resources as a way to give them full capacity credit. Those are some of the examples of the kinds of minutia that I think prevent us. I mean, we know right now that if we move forward with this 10 percent portfolio standard, that the likelihood—the estimates are that the Nation's bill will be lower, our reliance on imported LNG, in part, coming from places like Algeria, will be reduced. And yet a lot of these barriers will prevent that from happening.

Let me briefly, briefly talk about Nevada, because it is something that we are very pleased with. When we developed this job creation model, the State of Nevada had just passed a law requiring that it provide 15 percent of its energy resources by renewables by the year 2013. But there were still controversies. I mean, once you pass a law it has to be implemented, and there are still controversies. How much is it going to cost? Who is going to benefit from it? What kinds of economic development impetus is there? We made that model available in a cooperative agreement with the State AFL–CIO in Nevada, and I should stress that there was in no way any funding from the AFL–CIO. This is a completely cooperative agreement that we entered into with them.

We wanted to do it, in part, because I think it is important that working people understand that these kinds of initiatives can real-

ly be an important stimulus for the local economy. I first met with the president of the Nevada AFL–CIO about 3 weeks after September 11th. Each week something like 10,000 or 20,000 service workers had been laid off in Las Vegas alone, so they were very interested in economic diversification benefits. They were very interested in precisely what a 15 percent portfolio standard could do for the State in terms of specific job creations. We were able to provide them with at least a transparent and understandable estimate of what those jobs are.

Give you an example. If none of the manufacturing is located in Nevada related to the portfolio standard, there would be about 8,000 what are called full-time equivalent jobs created. If all of the manufacturing were to be relocated, it would be about 27,000 jobs. So one of our recommendations was that as the implementation of the portfolio standards go forward, incentives be provided to locate as much as manufacturing as possible within the State because of the job benefits.

If a portfolio standard is really a complicated social—not complicated, but a multi-dimensional initiative to capture the energy benefits, the environmental benefits, the security benefits, and the economic diversification benefits, then it is appropriate in the implementation of those standards to recognize those benefits and to provide things like extra credits depending upon the content of the local manufacturing for projects that come online. If a project comes online and has more local manufacturing, then that project can and should, in my opinion, receive extra benefits for doing that.

In conclusion, let me just say that I really appreciate the opportunity to come back and testify before you. I do think, Chairman Ose, what you said is exactly right: We need a modern energy infrastructure, and I think a substantial development of the renewable portfolios and technologies can provide that. Thank you very much.

[The prepared statement of Mr. Sterzinger follows:]

Testimony to the House Government Reform Committee Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs

Energy: Maximizing Resources; Meeting Our Needs; Retaining Jobs

June 17, 2002
Prepared Statement of George Sterzinger
Executive Director
Renewable Energy Policy Project

Chairman Ose, Congressman Tierney and members of the Committee, let me thank you for the invitation to address the Committee. The subject of your investigation – to maximize resources, meet our energy needs, and retain jobs – is one that concerns the Renewable Energy Policy Project (REPP).

REPP works to develop and support policies that will accelerate the market acceptance of renewable energy. We believe that accelerated acceptance of renewables will provide energy services at or below the cost of relying totally non-renewable technologies, take advantage of many local resources, such as biomass, that are currently underutilized or wasted, and provide a tremendous stimulus to local economies.

The benefits of renewable energy have been the subject of studies for many years. Those studies show convincingly that renewables can provide an important part of the next increment to the nation's supply infrastructure but are unlikely to do so without intervention to remove several barriers that currently block market acceptance. Delivering the benefits of renewable development to the people and localities that need jobs will build the understanding and support that can remove further blocks to renewable development, and so on. Let me summarize the major points of my Testimony:

- REPP is engaged in an ambitious undertaking that will allow localities, states, and the nation as a whole to determine with precision the job creation potential and even the types of jobs created as a result of renewable energy development. We began this work with a detailed survey of current manufacturing, installation, operation, and maintenance practices. Those practices serve as the basis for determining the precise job creation potential related to the development of renewable projects by technology type. REPP also intends to work with states and local agencies to capture as much of the potential offered by renewable development as possible.
- REPP has used the early versions of our work product with the state AFL-CIO in Nevada to determine the job creation potential of the Renewable Portfolio Standard passed into law in 2001. Nevada will require that 15% of electricity sold in the state be provided by renewable energy by 2013. The AFL-CIO strongly supports that initiative in part because of the economic diversification and job benefits it represents. The REPP analysis allows the AFL-CIO to understand the job benefits, assess the value of those benefits, and perhaps most importantly act to capture as many of those benefits for the

local economy as possible. Specifically, the Nevada AFL-CIO and REPP favor the implementation of an RPS that favors training and certification of installers and allows additional incentive for local manufacturing content. We also favor developing a full menu of economic development supports to enable new local businesses to participate in the cluster of economic activities that will be spun-off from the accelerated renewables development in Nevada. Based on this work, we believe there is substantial support for other states to take similar actions to encourage renewable development, and that this will be supported by organized labor and others interested in local economic development.

- From a national perspective, there is overwhelming evidence that renewable energy can provide reliable, safe, affordable energy. A recent analysis by the Energy Information Administration showed that, even with conservative assumptions, a 10% renewable base energy supply would lower the nation's energy bills by $15 billion per year by 2020 compared to a heavily fossil based supply mix.
- Despite the evidence showing the value of renewable generation, there are several important market barriers that will hinder or stop renewable development unless they are removed. Relying on deregulated wholesale markets and project development through so-called merchant financing will severely hinder renewable development. Sporadic, unpredictable commitment to production tax credits for renewables prevents an orderly development of the industry. Finally, several regulatory barriers unjustly penalize many renewable technologies which produce energy on an intermittent or sporadic basis.
- One way to cut through these impediments is to pass a federal Renewable Portfolio Standard that covered all sellers of electricity in a fair and non-discriminatory manner. Lacking a federal RPS, there are other actions that can be taken to address many if not all of these barriers and allow renewables to be developed at the state and local level to secure our energy needs, make maximum use of resources, and encourage job retention and creation.
- Incentives should be given to encourage states to pass renewable portfolio standards that offer long-term contracts for renewable project development. Production tax credits could be "grand fathered" to match the life of the renewable portfolio standard passed by a state into law. Regulatory reforms to halt the penalties presently assessed against intermittent renewable resources could also be passed. For example, intermittent renewable project development up to the level of maintained "spinning reserves" could be "firmed" by requiring the use of spinning reserves. Again an action of this type could

be tied into a package offered to states that pass portfolio standards in order to encourage their development.

REPP JOB ANALYSIS

Renewable energy development can provide substantial local economic development stimulus. REPP has been working on an ambitious effort to establish an accurate, current survey of industry practices in manufacturing, installation, operation and maintenance of all the major types of renewable technologies. That information allows us to calculate with some precision the precise potential job impact of all types of renewable projects, ranging from national portfolio standards to local municipal efforts. That work identifies the potential benefits. REPP is also working to capture as many of those potential benefits for local economies as possible.

Labor Requirements for Renewable Energy Technologies

Technology	Model Project Scale	Person-Years per MW
Solar PV	2-kW systems	35.5
Wind	37.5 MW	4.8
Biomass Co-Firing	100-750 MW	3.8-21.8

For the past six months we have been working with the state AFL-CIO in Nevada. As a result of that effort, organized labor strongly supports the RPS legislation passed by Nevada. We have filed testimony with the Commission in the state, specifically identifying the benefits and are now concerned with how best to capture those benefits. In part that testimony stated: "The Nevada AFL-CIO supported Senate Bill 382 and the establishment of the Renewable Portfolio Standard (RPS) for the state. At this time, we urge the Commission to adopt rules and regulations that will implement this legislation fairly and expeditiously. These comments first outline the broad reasons for this support and based on those reasons offer comments to the Commission on how the specific regulations implementing the law can preserve the important benefits the RPS offers. We believe the RPS can provide a stable source of reasonably and fairly priced electrical generation for Nevada. The renewable resources developed in response to the RPS will lessen our need for fossil fuels and enhance our national energy security. The renewable resources will provide important environmental benefits to the citizens of Nevada by lessening air pollution and saving water that otherwise would be consumed in thermo-electric generation. Finally, the RPS

will provide an important source of economic and job diversification." (Testimony of the Nevada AFL-CIO to the Public Utilities Commission. Attached)

The Testimony went on to calculate the specific job benefits that could be expected from the RPS: "The renewable technologies capable of meeting the RPS requirement are geographically diverse and modular. We believe that the majority of the RPS requirements will be met with solar, wind, geothermal, and biomass projects. Each technology will provide a different mix of employment. In addition, the job potential for Nevada will depend upon how much of the manufacturing activity locates in Nevada. In order to make an initial estimate of the job creation potential we rely upon recent work done by the Renewable Energy Policy Project to calculate the jobs related to renewable energy production. This survey work is attached as Appendix A to these comments. We believe the survey is useful for the Commission deliberations since it is based upon current industry practices.

In order to make an initial assessment of the job creation potential we had to make a number of assumptions. Those assumptions are presented in detail in the Appendix. Briefly, we assumed an initial retail kWh sales figure for 2003, calculated the required RPS generation for that year and assumed a breakdown for the various generation types to meet those requirements. Sales by technology type were then turned into installed capacity, which is used with the REPP jobs analysis to derive jobs. Jobs are broken down into a number of skill sets and also divided into broad categories. For these purposes, it is important to recognize that a number of the jobs calculated will be in the manufacturing process which may not be located in Nevada. The installation and on-going O&M jobs are also calculated and those are shown separately. The full calculations shown in Appendix A show that the RPS will create 8,092 FTE jobs in Nevada for the installation and O&M employment. Since the FTE calculation is for the entire ten-year period, on average the installation and O&M will add 809 jobs in Nevada for the period. Those are of course direct jobs and do not count any indirect employment multiplier. If the entire manufacturing process is added to the installation and O&M employment, the total rises to 27,229 for the ten-year or 2,729 on average. Of course, the manufacturing will have to be relocated to Nevada and so it is unrealistic to consider the full employment figure. As will be explained below, the difference between the employment value with and without manufacturing can be used to measure the value and the importance of providing incentives to suppliers to locate employment in Nevada. In calculating the cost offset we use two figures: the avoided

unemployment payments and the cost per job from the national survey of incubators as discussed below." (Testimony)

RENEWABLE MARKET BARRIERS

From a national perspective, a recent Energy Information Analysis of a 10% renewable portfolio standard showed that it would reduce the nation's energy bill by $15 billion per year. The specific EIA analysis, which was conservative in the technology assumptions and a number of other features, nevertheless showed overall energy bill declining as a result of the renewable development. With a 10% RPS, renewable energy will displace natural; gas and lower the cost of natural gas for all users. Although the EIA analysis does not go into detail, REPP believes that a renewable led decline in natural gas usage will lead to a reduction in the use of high cost imported liquefied natural gas (LNG). A program to accelerate the penetration of renewable energy will be lower in cost, provide obvious environmental benefits, and increase security.

Despite these benefits, many roadblocks stand in the way of renewable development. The major impediments were listed in the Summary.

- Merchant Plant Financing: To date there have been no renewable energy projects developed that relied solely upon merchant plant financing. This type of financing will, by its nature, tend to favor projects that use well know, tested technologies and that minimize capital costs relative to total kWh cost of production. To circumvent that problem, states have gone to Renewable Portfolio Standards that require the sellers of electricity to either develop renewable projects on their own or purchase renewable generation under long term contract from developers. In states where this has happened, such as Texas, renewable projects have been developed quickly and have usually been oversubscribed, that is more projects were offered for development than the RPS required.
- Uncertain Tax Treatment: The major tax incentive for renewable technologies has been the production tax credit. Unfortunately, that credit has not been available over a long time frame with certainty. As a result, renewable projects brought on-line have fluctuated wildly. Industries have operated at close to or in excess of full capacity or have seen project development drop dramatically. This makes the industry inefficient and leads to higher project costs.

- Wind and solar energy are two renewable technologies that are intermittent in nature, that is production is predictable but somewhat variable depending upon uncontrollable climactic conditions. This intermittency has led to problems with capacity credit for generation and balancing problems. Intermittent resources are often credited with zero capacity which means owners have to purchase redundant capacity, that is 1 KW of solar PV would have to preaches 1 KW of "firm" capacity in order to have firm power. Purchasers of intermittent renewable energy also can face balancing penalties. A purchaser of for example 100 kWh of wind or solar would have to pay a balancing penalty if the actual deliveries of the solar or wind resource were over or under the specified 100 kWh. These balancing penalties are often nonsymmetrical, that is the price paid for energy delivered in excess of the scheduled amount is often much less than the cost assessed for insufficient deliveries.

RENEWABLE MARKET TRANSFORMATION

Federal legislation to implement a national Renewable Portfolio Standard would cut through many of these problems, provided the RPS fairly treated all sellers of electricity and regions of the country. Lacking that standard, there are actions the federal government can take that will encourage states and localities to accelerate the development of renewables. Those actions fall into two categories: those that would encourage state or local action and those that would act to remove present barriers. In my opinion, the following actions would achieve a bit of both that is they would encourage states to act by removing barriers.

Many states are considering adopting Renewable Portfolio Standards. Federal actions to channel tax credits to those states would provide a positive incentive for them to act. In addition, actions to remove the penalties assessed against renewable, intermittent resources would also make the RPS resources more valuable and thereby provide an additional incentive.

Federal action that provided more consistent production tax credit treatment for renewable projects developed in states with an acceptable RPS would reduce the cost of the RPS to those states and channel tax incentives to those states. For example, the production tax credit could be offered to all renewable technologies that qualified under a state RPS and could be offered for a firm timer frame that would either be tied to the state RPS or simply made longer than would be

available to other states. The production tax credits could also be transferable to other taxable entities in the state.

Finally, the matrix of federal and state policies that govern the management of complicated power pools and power exchanges operate, most likely unintentionally, against many renewable resources. Interconnected power plants are currently required to maintain reserves against outages. These reserve requirements are system costs, that is they are assessed against all users of the interconnected system, even if the plants they own or have under contract are unlikely to require reserves of the magnitude required. These requirements favor large plants but they also provide an unused or underused resource that could be used to encourage renewable development. An intermittent, renewable resource is often not given any capacity credit in these pools and are therefore required to purchase capacity to be considered firm power. Federal action to require that "spinning reserve", that is plants kept running in order to be available at short notice to meet an unexpected outage, could be made available to "firm" renewable resources. Similarly, balancing requirements could be waived for renewable projects within a bandwidth of plus or minus 15% of scheduled power. Again, these actions would be offered as part of a program to encourage individual states to pass renewable portfolio standards. Federal supports of this type can provide powerful incentives to states to lead the way to acceleration of renewable technologies.

REPP experience convinces us that the energy, environmental and job creation benefits of renewables will lead to even greater public support. Federal actions to support aggressive state developments will be of great assistance in this process. Accelerating renewables will provide us with affordable energy, generated in an environmentally responsible manner, in such a way as to enhance security, and provide substantial economic stimulus to state and local economies.

Mr. OSE. Thank you, Mr. Sterzinger. The Chair recognizes the gentleman from Massachusetts.

Mr. TIERNEY. Thank you, Mr. Chairman, for this opportunity to introduce a gentleman who runs a corporation here in the 6th District. Spire Corp. develops, manufactures, and markets highly engineered photovoltaic module manufacturing equipment—and if we can get everybody to say that three times fast, we will be in good business—and provides advanced surface treatments for the biomedical industry. Millions of solar cells have been processed into modules Spire equipment. Spire's photovoltaic production equipment has been used to manufacture more than 90 percent of the photovoltaic modules on the market today. Spire equipment can be found in 141 customer facilities and 38 countries. The company was recently awarded a $2.7 million contract to provide a photovoltaic module production line to a company in Cyprus. Spire employs 100 people in the Bedford, Massachusetts area who manufacture equipment used to make parts for PV equipment, and Spire also has a plant in Chicago where it works for the city of Chicago, the Commonwealth Edison, the Illinois Department of Commerce and Community Affairs, and BP Solar. The company builds solar panels, integrates them into PV systems, and maintains the systems. To date, the company has installed 500 kilowatts of PV systems in Chicago, and it is my understanding, Mr. Little, that you employ about 100 people, am I right?

Mr. LITTLE. Not in Chicago, but in Bedford we do.

Mr. TIERNEY. In Bedford, Massachusetts.

Mr. LITTLE. Yes.

Mr. TIERNEY. Which is of much more interest to me than Chicago, believe me. [Laughter.]

Mr. LITTLE. Yes.

Mr. TIERNEY. I am happy to introduce Mr. Roger Little, the CEO of Spire Corp.

Mr. LITTLE. Thank you very much. This shows you solar electric systems in the field. Solar electricity is made from semiconductor materials. My assistant Dennis there has some solar cells that he will pass around, and you can keep them. They are fragile, they may break, but don't worry about it, they are cheap. So, solar electricity—the sunlight produces about a kilowatt per square meter, so if you have a module about the size of one of these boards, it will produce 150 watts of electricity. And, you put them all together and you have big systems, and they produce lots of electricity.

The market has been growing. I often say it is like a freight train. You can't stop it; it has great momentum. It has been growing at 25 percent per year for a decade. It will continue to grow. One of the reasons is that the world's population, about one-third of it, does not have electricity. So the bars show the growth of the market. This year it is about $3 billion. It is being helped a lot by favorable government programs in Japan and Germany, not so in the United States. The solid line shows a declining U.S. market share. It started at 80 percent back when, and currently it is down to about 30 percent. So one of the things we need to do is make this a more favorable climate for the manufacture and deployment of these solar electric systems.

By the year 2020, we envision that we will have as much as 10 billion watts of solar electricity covering various parts of buildings and various parts of the Earth. Small regions of Arizona, a 100 square-mile area, could provide all the solar electricity that you need in the United States.

Solar electricity is clean, so it has a significant effect upon the reduction of CO2, but more importantly, it makes jobs. So we could envision in the year 2020 to have almost a half a million jobs, quality jobs, producing solar electric modules and panels and systems to put in the field in the United States.

But you can see what has happened to market share and where the stuff is being made. You can see that the Japanese most recently have really made inroads. Sharp just announced that they are coming strongly into the United States, so even though the markets in the United States are growing, the competition worldwide is becoming more and more severe, especially coming out of Germany and Japan, where they are developing these markets and this business for international export.

Spire down in Bedford makes the equipment that makes the modules and also uses its own equipment to produce the modules. We have factories all over the world. It turns out, as I mentioned, that a great number of people in the world don't have electricity so that the factories generally go in developing nations. So we have factories in Kathmandu and Cerreto and places like that. Only recently have we come to the United States. We have established a factory in Chicago because the city of Chicago has provided us with favorable terms for the purchase of systems that we produce in that factory.

We recently, my assistant and I, went to Chicago and met with Mayor Daley and cut the ribbon on our new factory, and it is scheduled to employ about 50 people. We produce systems that the city purchases from us, puts on museums and schools. We have a number of schools with PV systems on the roofs, and it is a growing area. And we hope that we can export or we can duplicate that model throughout the United States. We believe every major city should have a PV production facility, certainly in the States themselves. We hope Massachusetts is going to be one in the not too far distant future, because of their own deregulation legislation, which sets aside certain money for these purposes.

That pretty much covers the points I wanted to cover. I would just like to say that one of the things that could help would be to continue or to expand the Department of Energy R&D budget as the current administration has not considered that a good place to put money to improve this technology and reduce its costs. Thank you very much.

[The prepared statement of Mr. Little follows:]

"Solar Energy: Maximizing Resources, Meeting Needs, Retaining Jobs"

Testimony of:
Roger G. Little
Spire Corporation
One Patriots Park
Bedford, MA

Presented to:
The Honorable Doug Ose and
The Honorable John Tierney

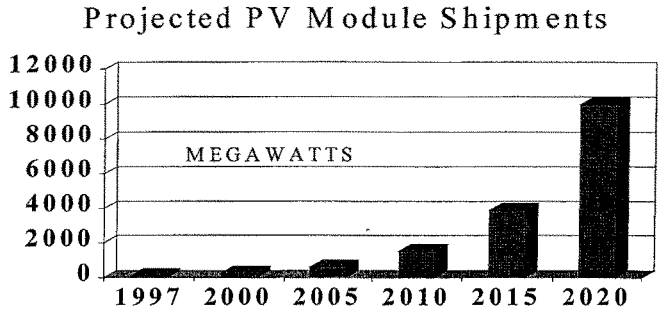
Presented at:
The Subcommittee on Energy Policy,
Natural Resources and Regulatory Affairs Hearing
June 17, 2002
Wiggins Auditorium
Peabody City Hall

Solar Electric Energy

Photovoltaic, or solar electricity converts sunlight directly into electricity. The concept has been known for over a century and a half; it was first demonstrated a century ago, and it has been commercialized by the space program fifty years ago, and on earth over 30 years ago. This technology generates electricity with no pollution and is quiet, safe and secure.

PV Market Growth

Photovoltaic markets grew 36% from 2000 to 2001, and have been growing at an annual rate of 41% from 1996 to 2001. Photovoltaic installations are used in many hundreds of thousands of locations in the world. Over 100,000 buildings in the world and over 10,000 in the U.S. get part or all of their electricity from photovoltaic energy.



At the present average growth rate,
PV module shipments will surpass 10 billion watts by 2020.

Manufacturing of PV Systems

The basic building block of photovoltaic systems is the module. This is crystalline silicon photovoltaic technology. The silicon crystal is "grown" and cut into wafers then converted into cells. These cells are soldered into strings, the length depending on the amount of voltage and power desired, and then is placed in a "sandwich" of high strength, low-iron glass and plastic compounds called encapsulants. The components are then treated to a vacuum and heat process called lamination to create an airtight barrier. The laminate is then tested for quality control, and framed as a photovoltaic module. Spire manufactures equipment to assemble solar cells into modules. Spire has established a factory for making modules and providing systems in Chicago.

Spire Solar Chicago – A Local Manufacturing Facility

Spire Solar Chicago is part of a Chicago Solar Partnership. The Partnership consists of the City of Chicago, through its Department of Environment, and the electric service provider ComEd. The Illinois Department of Commerce and Community Affairs is the Partnership's biggest source of funding. Through franchise renegotiations, deregulation and the growing importance of renewable energy sources such as photovoltaic electricity, the Chicago Solar Partnership has been key to introducing this application, making tremendous progress in just a few years. Spire Solar Chicago PV systems receive subsidies from both the state of Illinois and ComEd.

Solar "Brightfields" From "Brownfields"

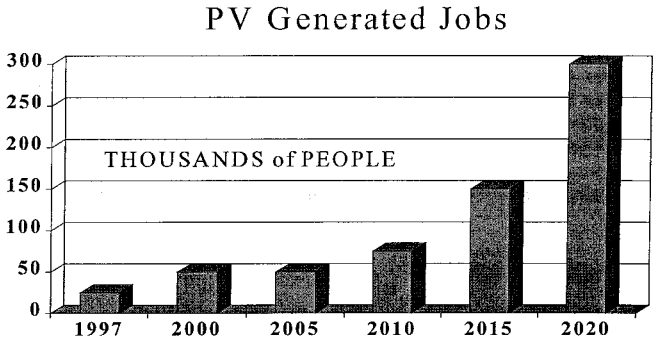
One of the important concepts used by the Partnership is "Brightfields", which is the conversion of polluted industrial sites to the generation of clean solar energy. Spire Solar Chicago is located on such a former "Brownfield", which is now the Chicago Center for Green technology.

Spire Solar Chicago in the last two years, has installed enough photovoltaic systems to power nearly one hundred homes, as well as installations, on museums, schools, government and private buildings. Chicago architects, builders and contractors are bringing the photovoltaic applications into their existing and planned buildings.

Through the leadership of officials like Chicago Mayor Richard M. Daley, a so-called "rust-belt" city like Chicago is becoming one of the greenest cities in the U.S. In order to maintain public confidence in this technology, Spire Solar Chicago has been maintaining a turnkey operation to control the entire process from manufacturing to design to oversight of installation and servicing.

Job Creation Through PV Module Manufacturing

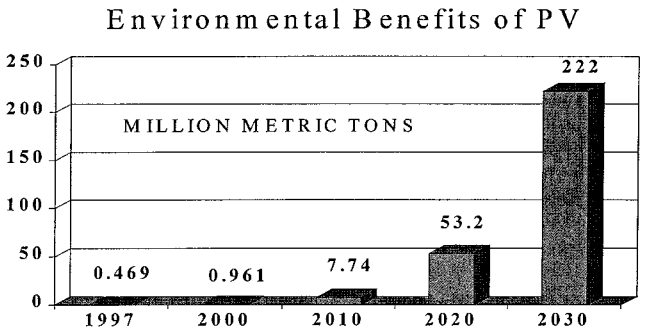
In assuring that the business operation in Chicago is a sustainable one, Spire operates Chicago with a baseline staff and production that will be steadily ramped up to meet project demand and maintain quality. Our goal is to have at least one megawatt per year (approximately fifty (50) modules/day) of production in the near future, which would require an additional one dozen production workers plus in-house support staff. Generally, for every worker Spire employs directly, there is an additional job created through delivery, installation and related support services. Within 10 years, we expect production output of 3 megawatts a year, which would result in about 50-55 in-house jobs plus a similar number of outside positions. As the industry grows, significantly more "clean energy" jobs will be created, as many as 300 thousand nationwide can be anticipated by 2020.



The PV industry will generate an enormous number of jobs.

Environmental Benefits of PV

PV produces no greenhouse gases, so its use could reduce the probability of global warming and climate change. It produces no atmospheric emissions. Its use curtails air pollution, which produces acid rain, soil damage, plant and animal damage and human respiratory ailments. Under present growth trends, by 2030 installed PV systems will offset 222 million tons of CO_2 yearly — equivalent to that generated by 50 million cars.



Mr. OSE. Thank the gentleman. Thank you, Mr. Little, for your remarks. The typical manner in which we proceed is we will ask questions now and we alternate. Out of deference to being in Peabody, we are going to let Congressman Tierney go first, so the gentleman is recognized.

Mr. TIERNEY. I thank you, and thank, Mr. Chairman, for that deference. We could be here the better part of the week, I suspect, if we wanted to talk about all the issues that you brought up, but let me start with a general question, if I could, for the panel, and maybe we could just clip some short answers if that is possible. If I asked each of you to just give me the rundown of what are the three most important public policy things that could be done to move us in the direction about which we talked, would you just list those for us, for the record, starting with Mr. Bernow.

Mr. BERNOW. I would say progressive Corporate Average Fuel Efficiency standards for vehicles that would push the technologies for transport, a progressive renewable portfolio standard reaching probably as much as 20 percent by the year 2020 and some for of direct control on CO2, either through an electric sector cap-and-trade system or an economy-wide auction-and-trade system for carbon dioxide.

Mr. SWIFT. Do I get to vote for his and also give you some new ones?

Mr. TIERNEY. Absolutely. That is what I am looking for.

Mr. SWIFT. That sounds great. No, I totally agree with the need to cap carbon, implement a carbon policy as a major, major priority. I would also like to add, I would like to see the substitution of cap-and-trade systems for these inflexible New Source Review type requirements, understanding we can't let go of those until we have a better system, but there are much better systems that should substitute for those. Second, reiterating a point made, I would like to see a wires charge on all electricity that would go to support research and development. This is a critical, critical lack of funding for research and development in this country. And, third, I think the car issues, we have got to implement the hybrid electric vehicle comprehensively through whatever regulatory strategy we can, such as increased CAFE standards.

Mr. TIERNEY. Thank you. Mr. Fairman.

Mr. FAIRMAN. Thank you. Again, speaking on behalf of the Expert Group and highlighting their priorities, I think No. 1 would be in transportation, yes, to increasing fuel efficiency, perhaps not only through CAFE but through some blend of incentive measures. This group is particularly interested in the notion of feebates and also in a tradeable CAFE standards credit, which I can say a little bit more about if you are interested. Second, in the electric sector, although there is strong interest in renewables, there is even stronger interest in leveling the playing field for distributed generation and for efficiency to be equally cost competitive in a still somewhat regulated environment where utilities have a regulated rate of return. And, third, with regard to climate, echoing the point made earlier, a single economy-wide instrument, preferably a tax or a tradeable permit system.

Mr. TIERNEY. Thank you.

Mr. STERBINGER. Let me concentrate mainly on the electric. I certainly agree on the transportation. I think that we desperately need reorientation of the research and development and demonstration effort in the United States. Everybody has said it, but I think that one simple way to think of it is the statisticians talk about Type I and Type II errors, and Catholics talk about sins of omission and sins of commission, and it is very important distinction. I mean, sometimes I think we worry about not doing something that may be wrong rather than making sure that we—and neglect the fact that we are not doing something that is right. I mean you can really overly protect yourself and sort of erect barriers to doing anything because it might be wrong, and you lose the opportunity to move ahead.

I think research, and development, and demonstration. The demonstration part is an important part of that piece because the renewables industry in particular is characterized by staggering amounts of innovation on all the different fuels and conversion technologies, in laboratories, and in think tanks, and in universities around the country. And, I forget who but someone mentioned the performance of the venture capitalists and going through the Death Valley, from the prototype to the market acceptance, and that is extremely important. I think that Government assistance, appropriate Government assistance blended in in the right way to make sure that there is a way to take viable technologies with potential market adaptation through not only the research and development but also the demonstration.

Demonstration generally means performing under market-like conditions on commercially acceptable terms. That last step is very, very important. And, if you look at industry from industry to industry to industry, you will see that the wind technology has moved offshore, the photovoltaic technology is moving offshore, and there are equally important stories along those. So I think it is very, very important to pursue that.

I think it is also important to recognize that there are both Federal and State initiatives, and one of the Federal initiatives could be to encourage aggressive State actions. Right now, not to belabor the point, but the State of Nevada has this 15 percent portfolio standard. A firm 5-year production tax credit available for all renewable technologies will actually provide a benefit to that State because tax credits will tend to flow to it. There may be other ways in addition to sort of encourage States to move beyond what may be the comfortable Federal level on a renewable portfolio standard. I think it is a time when movement forward really should be encouraged on both levels. The State actions can feed the Federal actions.

There was a joke during the Enron time about how they would have a big policy matrix that they would go down and look at the cost of every policy in order to figure out what it was going to cost them, and I think there is—I am sure they did that. A lot of other people do it as well. I think as you move forward, toward climate change, toward carbon caps, and so on and so forth, I think it is very important to recognize that there is that kind of policy matrix, people do look at the cost of it. And I think by pushing this State innovation you can feed Federal actions. By pushing those Federal

actions, you can bring along the technology that will actually reduce the costs of meeting all those long-terms goals. So I think that is also an extremely important change.

Mr. TIERNEY. Thank you.

Mr. LITTLE. I certainly support what has been said. I would just emphasize that the DOE, Department of Energy, solar energy budget has taken hits over the years, and it really is the foundation for reducing costs of solar electric energy. And that, of course, leads to the growth of the business in the United States.

Mr. TIERNEY. Just a minute ago, Mr. Sterzinger was talking about the Federal Government taking some action to encourage aggressive State action. What types of flexible policies do you think might the Federal Government consider to bring about that kind of reaction or do you think that is not the proper way to proceed?

Mr. SWIFT. I think States are great sources of innovation and progress, and I think Massachusetts has had a history of that. Bringing about that through Federal policy is a complex matter that would depend on the sector and set of regulations involved, but things that—I mean let me give you one example, the cap-and-trade systems we are talking about for carbon or for the——

Mr. TIERNEY. Would you explain a little bit for folks that are here? We are always referring to it as the cap-and-trade system, but it might bear some explanation.

Mr. SWIFT. Sure. There are basically two or three paradigms by which you can regulate environmental contaminants and pollution. The traditional way is to set rate-based standards for every pipe, and that was embodied in the 1970's Clean Air Act and Clean Water Act in which Congress, reflecting public understanding, visualized technologies such as the internal combustion engine or coal-fired power plants to be permanent. And the only thing you could do with them to achieve environmental quality was you put a gizmo at the end of the pipe to reduce that pollution. And that is embodied in standards like the famous BACT, RACT, MACT standards of the Clean Air Act. And I want to explain that as other than to say——

Mr. TIERNEY. I was going to say that was very helpful. Thank you. [Laughter.]

Mr. SWIFT. Under these standards, the Federal Government requires State governments to impose rate standards on their plants, and the "ACT" part of it is "Available Control Technologies." If you are a new plant, it is "Best Available Control Technologies." If you are an existing plant, it is reasonably available control technologies.

But what I want to point out is that the standard is based on "available"— which means existing—"control" technologies, which means end-of-pipe. What you really want are innovative process technologies. I have seen many of these innovators with these brilliant technologies just crash against the rocks of the bureaucracies saying, "You are not available. Show me where you have been demonstrated and practiced before." And they say, "Well, of course I am not available, I am innovative." "Are you a control technology? EPA has given me this ACT document—Available Control Technologies document—I don't see you in there." "Well, of course I am not. I am not a control technology, I am prevention." And they go into

this dialog for years and years, and by that time the money is over and they are finished as a business, even if they have the best, most imaginative, greatest product.

So how do you get States to be forward-looking? I think one way is to create these more automatic systems, like a cap-and-trade system that creates a cap over the entire industry, limiting pollution, so that it will never rise again. In contrast, rate-based standards allow pollution to increase with growth, the allowance trading program allows the reductions to be made in an effective place.

What I might mention to the Congressman is that you have got to think a little bit about how these systems mesh with the States. In my opinion, something we don't do in these laws, such as the acid rain law, is that States, in a sense, are not allowed to take these allowances off the table. If a State wants to do more stringent regulation, I think it should be allowed to take allowances off the table. A State should not be allowed to tinker with the system the way New York did in saying you can't sell upwind, you can only sell downwind, because that is too great an interference with the working of the system. But States should be able to take allowances off the table.

Mr. TIERNEY. What do you mean by taking allowances off the table?

Mr. SWIFT. Well, Massachusetts just passed a four-pollutant bill, and it was purely through rate-based approaches. One of the points is that once you have a cap-and-trade system, which is what we are under in Massachusetts for NOx and SOx, rate-based regulation no longer provides any environmental benefit, because the—I forget the names of the plants here—Salem Harbor, for instance, it reduces its pollution, but that will migrate to a different place. And, even though the cap-and-trade systems are far better overall, I would think you do want to allow a State to say, "Well, if you are going to reduce your pollutant, we are going to capture that and take your Federal allowances off the table." But you are going to need a Federal act authorizing you to do that, because otherwise it is interference.

The simple point is that you have got to think a little bit about how cap-and-trade meshes with State-based regulatory systems. And it gives you some more opportunities to allow States greater powers, but they have not been taken advantage of so far.

Mr. TIERNEY. Thank you. Mr. Sterzinger or Mr. Fairman, either one of you on that, you both mentioned the progressive renewable portfolio standard, and I assume you are both familiar with that part of the Senate energy bill that deals with that. Would you tell us your impression of the Senate bill's content in that regard as opposed to where you would like to be or like to see the policy drive, whichever order you like.

Mr. STERZINGER. I think the Senate bill, at least the last time I looked at it, was disappointing. It does set a portfolio standard, but it has about three or four significant exemptions which really weaken it. It exempted all municipal and co-op systems, it defined the percent in a confusing manner—the last time I had seen anything like it was when I was reading the instructions on how to file my Internal Revenue Service taxes. I mean it was 10 percent, but

it is 10 percent of the sales minus the 10 percent that is renewable, so it lowered it a bit.

Nevertheless, I think it is positive primarily in that it will provide a floor. I think the great benefit of the renewable portfolio standard is that it requires the affected States or the affected retail sellers of electricity and the State regulators that oversee them to break through this roadblock of contracting that has basically stopped renewable development or—well, it has certainly slowed it down. So I think any renewable portfolio standard is a step in the right direction.

I worry if the impact gets too small that the implementation costs, the processes of starting it, the potential controversies that might arise if one State has to basically send money to another State as a result of it, can overwhelm the benefit. So I would like to see it made applicable across all of the different providers. Not to pick on Nebraska, but basically the entire Nebraska is exempted because it is a municipal electric system, so any renewables that they develop they could sell to Illinois, which would then prevent the development of renewables in Illinois and result in people sending money out of Illinois into Nebraska. In my experience, in State regulation and a lot of others, people don't like to send money across State lines. There is a real strong local component to this that I think you need to be careful of.

If I could just say one more thing. On the sort of what the Federal Government can do to increase or encourage initiatives in the State, I think it is important to sort of step back from this. There are plenty of examples in the transportation sector and others of where every sort of—or a number of Federal supports are sort of bundled together and then aimed at inducing the State to do something or making sure they don't do something else, like break the 55-mile an hour speed limit or live within their NOx budgets, or something like that.

I think on the renewable side, you know, you can think of a number of things. Everything from allowing a production tax credit maybe only for States that are above the national standard, all the way to trying to find ways to coordinate something that is seemingly remote as the community development support under the U.S. Treasury Department for the support and development of local businesses that would be part of the cluster of activities that would result from these aggressive standards could all be brought to bear for a State that chose to do something more aggressive than a national standard, so that you are really creating a number of supports and incentives to get the States—so that people just don't say, "Well, there is a national standard, there is nothing more we need to do." I think that would be really wrong. Even if there is a national standard, there are a lot of reasons to try and get the States out there proving that they can do more, proving that it is good for them, proving that they can capture these benefits, proving that it is supported by the electors of their States.

Mr. OSE. Would the gentleman yield for a moment?

Mr. TIERNEY. Certainly.

Mr. OSE. Mr. Sterzinger, you talked about four exemptions in the Senate bill under the renewable portfolio title.

Mr. STERZINGER. Yes.

Mr. OSE. Munis and co-ops, is that two or one? Munis is one, co-ops is two?

Mr. STERZINGER. No, that was one. I am not sure I can remember every one. Go ahead, though.

Mr. OSE. Well, I am curious of the other three, and I guess this question kind of jumps over to Mr. Little in that if there is a whole slew of exemptions on the renewable portfolio title, does that not mean that the 50 jobs, for instance, that Mr. Little's creating in Chicago or the 100 here in Bedford are put at risk?

Mr. STERZINGER. I don't think it is——

Mr. OSE. If these things are tradeable across State lines.

Mr. STERZINGER. Well, I don't think it puts at risk Roger's current level. I think it may affect his plans for expansion in Illinois or in Massachusetts or in other places, but I will let him speak to that.

I am trying to remember the exemptions or the modifications in the Senate bill, and I am not coming up with them right now; I apologize. Generally, it led to something that was I think a very moderate—if you looked at the real net introduction of renewable capacity between now and 2020, it was very moderate, and it did raise some concerns.

Mr. LITTLE. Well, of course, the jobs are local, so even though you might trade credits across various regions, people want manufacturing in their city, so that always goes in our favor. As a member of the Solar Energy Industries Association, we support the Senate bill, especially net metering, so this is something you can have a major effect on, net metering. But also the Senate bill only requires States to consider net metering, not to really do it. But if there were some legislation which says net metering should be done throughout the country, that would help a lot.

Mr. OSE. I thank the gentleman.

Mr. TIERNEY. Mr. Little, while I have your attention, tell us what they are doing in Germany and Japan that perhaps we ought to consider doing here to facilitate the growth of the solar industry.

Mr. LITTLE. Well, solar electric technology is expensive, and so they have various means of offsetting the cost to the customer. In Japan, the homeowners are provided with 30 percent subsidy for the systems they put on their roofs. So they have been oversubscribed in Japan for electrifying homes. In Germany, one incentive they have is to buy back the electricity from the person who might have it on his roof at very favorable rates, at rates which are higher than that person pays for his electricity from the utility. And, that has caused homeowners to almost become small micro utilities themselves, and that has stimulated the market.

Mr. TIERNEY. Thank you. Mr. Bernow, the efficiency standards that I mentioned in my opening remarks for appliances, I believe, are saving a huge amount of money and projected to save much more by 2020. Can you extrapolate out on that and tell us whether you think that the adoption of additional standards for other appliances is possible, and what might some of those be and where would it take us?

Mr. BERNOW. The efficiency standards that are embodied in our study—by the way, a study that used the Department of Energy's models, the same model that was used by the Department of En-

ergy and Environmental Protection Agency's clean energy future study—those standards are more aggressive than the ones that are now embodied in law. They are in our study and in related studies that we cite. They cut across all end uses, from the use of heat pumps, cutting-edge technologies to do both heating and cooling, to fuel cells, to cutting-edge air conditioning, dishwashers, all appliances, new building codes, all of which are well-established technologies and techniques. And they cut well beyond what is currently embodied in the standards.

Mr. TIERNEY. Mr. Swift, can we do that in a way that is mandatory and flexible?

Mr. SWIFT. Of course. I was actually going to comment on your question that every study you can read out there will tell you that we can save 25 percent of our national energy through profitable energy conservation measures. And, it is remarkable that none of us, however, mentioned that in our top three priorities because the problem has been so intractable. How do you get lots of consumers to take small actions? And, need I tell you what would work like a charm is raising energy prices?

Mr. OSE. Have at it, Mr. Swift?

Mr. SWIFT. Exactly. It is the T word, and that is why the issue of taxes also doesn't even enter our discussions. It is not viable, and how to create the drive for efficiency through a sensible, flexible regulatory mechanism has frustrated people, and I don't have a good answer. We were getting there with the power industry before deregulation, and I know there are some good thinkers that would have some suggestions for your office, but there are no easy answers, and I would have to consult them for a more sophisticated answer.

Mr. TIERNEY. We may get back to you for that.

Mr. SWIFT. Thanks.

Mr. TIERNEY. I think two areas. One is individual consumers, obviously, and we have got to find some way to motivate them to do it. I think leadership has a lot to do with that. I think people are still afraid they are going to have to put on Jimmy Carter's warm sweater, and that is no longer the case. The technology has come so far since the 1970's that is not the issue, and we somehow have to project that up and put it on our screens and get some leaders out there talking about this on a regular basis so that people are encouraged to do it.

The other note I make is the impact on small business. The amount of moneys that small businesses can save in my district and Congressman Ose's district and others somehow has to be brought home to them. We have people in this district that in fact have won green awards for putting together buildings that saved them almost 85 percent of their electricity costs and their energy costs in their buildings. And, if people would understand that—I was a small business person for 22 years. You would love to be able to save that kind of money on your energy moving forward. So we have to find a way to get that information out there and do it in a way that is somehow going to be digested. Because I suggest, as you saw Mr. Ose's reaction on that, if you want to raise the taxes on it or you want to do something of that nature, have fun. We will see where that gets us all.

Mr. Fairman, you made a point that I think can be helpful, though, and having read the NEPI report, which, Mr. Ose, we ask that report, by unanimous consent, be placed on the record——

Mr. OSE. Without objection.

Mr. TIERNEY [continuing]. Together with the other witnesses' reports and materials.

Mr. OSE. Without objection.

Mr. TIERNEY. Thank you.

[NOTE.—The NEPI report referred to may be found in subcommittee files.]

Mr. TIERNEY. You mentioned purchasing. Will you expand on that a little bit about just what the Federal Government and the State governments could make as an impact if they change their purchasing policies with respect to efficiency and conservation as well as renewables and things of that nature?

Mr. FAIRMAN. Thank you. I can elaborate a little on that. If I may take a moment, I had just wanted to make two brief comments with regard to the renewable portfolio standard and efficiency, very briefly.

Mr. TIERNEY. Go ahead.

Mr. FAIRMAN. The Expert Group did not reach consensus in support of renewable portfolio standard and that was primarily because of a combination of philosophical and practical differences between those who see the main focus needing to be the removal of barriers to competition on the performance-based standard for different kinds of energy supplies as well as demand side initiatives on one hand and those who feel strongly that transformational efforts like the development of the renewables industry require a more proactive Government action.

So just to be clear about this, some in the room felt that the best way to support the development of renewables as an industry is to have clear, across-the-board requirements for utilities in the purchase of power that significantly penalize dirty sources. And, that if you did that along with removing other regulatory barriers, as was alluded to before, to the use of renewables, that you would, in fact, get the same effect without some of the, from the point of view of an economic purist, distortions involved in creating a standard that immediately gets you tied up in knots around an interstate transmission and regulation.

On energy efficiency, I just want to emphasize that the Expert Group felt very strongly about the availability of many options and programs that could substantially improve efficiency across a range of sectors, as Dr. Bernow's presentation alluded to. And, I just want to mention, as a footnote, one program that is separate from this initiative my organization was involved with called the Northeast Energy Efficiency Partnership that is very much actively engaged in market transformation efforts, especially targeting medium and small businesses, and a lot of the leverage comes through changing the incentives for utilities to do more aggressive outreach, to have financial incentives to do so, to promote efficiency investments among their customers.

With regard to purchasing and procurement then, I think the main thing that the group wanted to focus on was the reality that Federal procurement practices have already had a significant im-

pact in industries, such as automobile manufacturing, to some extent in appliances, and that could be further leveraged through more aggressive requirements and standards for purchasing. The group did not discuss any individual program ideas in depth, but felt strongly that there is a wide range of options available, especially in regard to buildings and facilities.

Mr. TIERNEY. Thank you. If people were to look at the energy consumption by sector, a chart down there, they would see the transportation dollars up almost 27 percent of the energy, and all of you, you were universal in your comments about the corporate—the CAFE standards—and the reason I got hung up on the word "corporate" was Doug reminded me I used the word "carbon" earlier and I shouldn't have—but the Corporate Average Fuel Efficiency standard. Any conservationalist or environmentalist would have to be disappointed with the reluctance of Congress in both bodies, in both parties to move on this issue. And, I think, it is an absolute disgrace that the Congress cannot find a way to change the standards, particularly when you look at the amount of gallons that have been saved with just the standards that we have so far and the huge amount of money that has been saved by the consumers over the period of time. Do any of you care to make any comments about the CAFE standards and what we can do to break what seems to be an intransigent group of Democrats and Republicans, many of whom are from automobile manufacturing States, or whatever, who seem to not realize the potential or the danger of losing that business, much as we had the problem with other countries building smaller cars in earlier years? Mr. Bernow, you want to comment?

Mr. BERNOW. Well, I would say, just rolling this discussion back a bit, this is true for both appliance and building efficiency standards as well as fuel efficiency standards for automobiles. This is a tried and true policy and it has worked for appliance equipment and in households and in offices, and it has worked for automobiles. Massive savings on both accounts. This is a well-known regulatory procedure, which economists would admit sometimes the standard is the most efficient way to reach a goal and not necessarily the market.

I would say with regard to the Corporate Fuel Efficiency Standards for automobiles that there are real benefits to be gained. Our study shows that when we break down the job impacts by policy and we looked at this to some degree specifically for the fuel efficiency standards, we were able to see that there were job increases associated with the savings that households would reap from those greater efficiencies. Those savings are re-spent throughout the economy, small businesses especially, and so there are job impacts, job savings, that could be part of the way in which we can convince ourselves and the citizens and lawmakers to take this quite seriously.

Mr. TIERNEY. Anybody else care to comment?

Mr. SWIFT. Well, I think it is—I am far less in statute to yourselves and others on the political issues, but how to convince the AFL–CIO that they could make as much money building a high-technology car as a fuel-inefficient car seems to be one of the greatest single needs to move this issue forward.

Mr. TIERNEY. Interesting enough, as you bring that up, one of my colleagues from Michigan has told me that in running a poll of people out there and asking about the CAFE standards and other standards like that, 65 or 68 percent of the people, even in union households out there, favored moving to a cleaner technology and a cleaner car. So I think there may be some disconnect between the Washington hierarchy there and the local situation, and a lot of it probably has to do with education and reaction on that. But you are right, that is as much a serious barrier, as is the attitude of organized labor toward jobs and job loss. But I think there has been a significant amount of work done and Mr. Sterzinger's work out there has gone a long way toward sort of breaking through the stereotypical attitudes on that.

We didn't speak to this particular aspect of it, but I had a long conversation a couple of weeks ago with Kent Conrad, a Senator from North Dakota, and we talked about the farm bill, and without getting into that avenue—I think it was an abomination, but others may have different views on that—but one of the reasons we are giving huge subsidies to farmers is their at least asserted inability to get back a profit on their acreage out there. Tell me whether or not this is your view, but one of the experts at this conference with Kent and I was saying that you could probably lease or get almost $4,000 per acre in lease funds for wind farms. In a State like North Dakota, which would make a significant difference with making those areas profitable, because they are now only making somewhere between $350 and $750 per acre in profit for what they are growing, it would go a long way toward removing the need for subsidies and in a large way toward keeping farmers farming while they are also profitable. The problems seem to be that not enough money being spent on the dual issues of storage, some way to capture that energy and preserve it, and then transmission, some way of connectivity, of getting it out there. Would anybody care to comment on that? Mr. Sterzinger.

Mr. STERZINGER. I spent 3 days in Bismarck, North Dakota a couple of winters ago, so I actually—it was before I started to work at the Renewable Energy Policy Project and I had a client, the Turtle Mountain Indian Tribe, that is up near the Canadian border that was trying to develop wind. There were 400 farmers that came to that meeting in the middle of the winter in Bismarck, and that is exactly the reason that they came. The current royalties are between $1,000 and $2,000 per megawatt per year, and with the current size of wind turbines, depending on the topography of the land, it is a very, very realistic goal.

Interestingly, people also were talking about the agricultural co-ops joining together so that the best land would be used for the wind development without having necessarily a windfall—no pun intended—go to a few landowners and that the money be shared by the co-op as a whole so that the development could be more orderly.

There is absolutely no question—in that conference, I mean, they asked someone from the Western Area Power Administration to come and talk about what could be done. And they said, "Well, from our perspective, the best you could do is 50 megawatts exported from the State before you destabilize the system." And, I

have always believed that asking a transmission engineer what can you do is exactly the wrong point to start any of these discussions, because transmission is one of the fundamental mysteries of the universe, and it is very difficult to tell exactly what is going on in a transmission grid. It is very hard to prove that you can do something, and a lot of the law firms in Washington I think really make their living, their bread and butter is on transmission disputes before FERC and on other sort of related issues.

My feeling, I would differ slightly on the idea of storage. I think if you had a very economic storage technique, that would be doable, but to my mind, the great problem is the transmission interconnections out of North Dakota to the markets that can use them. And, I guess, the sort of really remarkable, I don't know if it is an irony, but the juxtaposition was that the Western Area Power Administration had been formed precisely as a transmission grid to bring power from remote hydroelectric dams to markets.

And, there they were saying that remote wind projects—and the potential in North Dakota is gigantic. I mean the wind resource, the class four to six wind resources are absolutely phenomenal and the amount of energy that you could generate is substantial. I think that the capacity issue can be addressed in other ways. I mean I do think that the reserve and capacity requirements of power pools need to be rethought. We subsidized large individual units and we penalize unmercifully intermittent, probablistic resources.

I think I would go first for a transmission effort. Somebody should think about at least a transmission effort to parallel the Western Area Power Administration, what they did for hydro in terms of what they could do for the wind resource that is out there right now. I would look at the reserve requirements of the different markets and try to find ways to sort of address those. But there is no question. I mean 400 farmers, and people vote with their feet, 400 farmers in the middle of winter coming to a conference on wind development was an absolute blueprint stamp of approval on what they thought the economic potential was.

Mr. FAIRMAN. Just briefly, the question of what farmers have to do with the energy sector came up in several ways in our discussions. Three main things were cited. One, of course, is the wind power option; the second is the growing of cellulose as thick grasses that can be a double benefit, both as a fuel source and as conservation tillage, and the third was perhaps even more interesting, some experiments that have gone on in the West involving farmers agreeing to use land for carbon sequestration in order to give power plants who had supplied them carbon credits. These, of course, have no current regulatory value in the United States because we don't have carbon regulated, but there have been some interesting discussions in a couple of pilots to see whether that kind of package can be put together. So I think that there are many areas of relevance. This Expert Group mainly focused on the idea broadly of trying to integrate the farm sector effectively in the strategy.

Mr. LITTLE. I just might comment that certainly the real estate is important in renewable energy because it is such a diffuse source of energy. We take it a step further in photovoltaics. We try to put big arrays on brownfields and get the offset that you get from not

having to clean up the brownfield as much as you would normally do. So we get a benefit by covering a brownfield with a photovoltaic array.

Mr. TIERNEY. Let me ask you, Mr. Little, we have a sizable area over in Lynn that used to be the General Electric Plant. It is still there but a lot of the property has been out of use; in fact, some of the buildings have been taken down and it has been leveled off and fenced in. And we are talking many acres of land. Is that the type of area that a company like yours could go in, utilize as a manufacturing facility and do something with?

Mr. LITTLE. That is a perfect situation. In fact, we are studying a situation just like that now in Brockton where they have a brownfield, and we are studying the feasibility of putting a factory on the brownfield, producing modules and covering the brownfield to cut back on the cost of cleanup.

Mr. OSE. Gentleman, I have a number of questions. Mr. Little, I first want to apologize. Neither John nor I are an engineer, but we have managed to damage both of these, and they are on the exact same diagonal cut, so there is something in your manufacturing process about putting these things together right at this point. So we apologize for damaging private property.

A couple questions if I might. Congressman Tierney asked you each about the three most important aspects, and you all talked about the cap-and-trade programs or some variation thereof. But Dr. Fairman, you talked about distributed generation versus transmission, and we have had untold agony in California about this issue. We could talk about the relative efficiencies of this kind of transmission facility in hot weather versus this kind in cold and the difficulty of building lines and what have you. The Expert Group talked about this and they had a recommendation. Could you expand on what you talked about within the distributed power discussion that you had?

Mr. FAIRMAN. I will do my best. The main focus of the discussion was that in principle distributed generation can have several different kinds of benefits. One, it can help diversify sources of energy and potentially in some areas make less polluting sources more competitive. For example, the combined heat and power option, which is a form of efficiency-increasing distributed generation. Another example is having a small wind farm that could supply a local area more cheaply than it could if it was required to supply a broader area. It goes also back to some of the regulatory disincentives for small producers to try and join the grid.

Second was the notion that distributed power as a national security strategy makes a lot of sense. If large facilities are more vulnerable to disruption, you get greater resilience from a security standpoint from greater distribution of those assets.

And, the third was that if the interconnection of many different forms of distributed generation could be made simple and easy, you could, in a longer-term scenario, have a fairly radical potential transformation of the power system. For example, if we actually move toward a significant share of the automobile fleet being hydrogen-fueled vehicles, and those vehicles while parked and stationary could serve to power homes or even neighborhoods, you could have a significant benefit on many levels, but it won't happen

unless the ease of interconnection, in both a technical sense and a regulatory sense, is much greater than it is today.

We did not get into the specifics of California's situation. I am sure that in any regulatory jurisdiction there are many complexities involved. All that was acknowledged, but the thrust of the recommendation was we can and should make this a lot simpler to do.

Mr. OSE. Mr. Little, your business enterprise is effectively distributed generation. Dr. Fairman talks about the interconnection issues. In California, we have an ongoing battle between the investor-owned utilities who collect natural gas and the independent producers who produce natural gas and releases, and how you get that gas into the main pipeline. Do you have similar issues in terms of—as I understand it, you make the equipment that makes the photovoltaic stuff. Do your clients have these same kind of problems?

Mr. LITTLE. Interconnection is a big issue with photovoltaics. We make the equipment and then we use our own equipment to produce systems in Chicago, so we are dealing with interconnection all the time. And, on a Federal level, there are things that can be done to make interconnection issues for renewable energy sources better.

Mr. OSE. Such as?

Mr. LITTLE. Well, I would have to refer to my notes here. Standardization is really what it all boils down to and making sure that from State to State you can use the same technology, the same power conditioning, the same criteria for your renewable energy system without having to tweak it for every utility and every interconnect.

Mr. OSE. You have a preemption at the Federal level for that power created under this renewable portfolio title, for instance.

Mr. LITTLE. Yes.

Mr. OSE. How would that—Mr. Sterzinger, that seems to me—we would have a lot of feedback, it would seem, from the States on something like that. What could we expect?

Mr. STERZINGER. Well, you expect a lot of feedback.

Mr. OSE. I do expect a lot of feedback.

Mr. STERZINGER. I think it is—there are real concerns and then there are concerns that are raised I think simply out of a conservatism, out of a desire to sort of preserve the status quo. And, I think, what Roger said is exactly right. You look at a photovoltaic installation or any kind of installation and there are engineering issues and then there are what I would call sort of the softer regulatory issues, things like you have a distributed generator steam—multiple generators in steam, the kind of what is called sort of standby capacity that you are charged for that can be a killer. I mean, it can absolutely wipe out the economics of it.

I think a thing that Roger said earlier that is very important, especially for his business, on the net metering provisions, both the engineering interconnection and the net metering provisions I think need at least to have that sort of national airing and hopefully a national override. I mean the standardization of the equipment is something that would greatly benefit, because it answers the questions. I mean it lowers the transaction cost of doing this. These are sometimes, especially in the early stages, relatively

small projects, and people are simply not going to be willing—they don't have the money, the sort development money to go into Rhode Island or Massachusetts or Vermont to fight out the local interests on those standards, so it can stop it.

Mr. OSE. That was Mr. Swift's point earlier about having the capital available to actually create these processes from start to finish. Now, one of the challenges there when you talk about—you are talking about not so much a standardization of the equipment but a standardization of the interconnection. So one of Mr. Swift's points was that if you moved a single technology, you basically close the doors to a lot of innovation that might otherwise occur. I don't think you are suggesting that, are you?

Mr. STERZINGER. I think in this case, it is that balance of the sort of sins of omission and sins of commission. I think in this case, you want to move these forward. I mean there is a clear, I think, demonstrated advantage that we haven't even really begun to talk about in detail, and these are relatively minor issues that simply can exhaust a business' resource or an industry's resources in approaching them. And, I think, that in that case the nationalization would really provide a platform that then would allow a lot of other innovation. But if you had a sort of standardization of interconnect and net metering standards, I think you could expect a sort of flowering of photovoltaic technologies rather than something that would be a roadblock to them.

Mr. OSE. One of the Federal agencies that is under the jurisdiction of my subcommittee is FERC.

Mr. TIERNEY. We have time for maybe one or two more questions, then a short break, and then maybe come back and address some of the questions that were submitted.

One question I just had generally and that is can give you us a brief synopsis, those of you that know, how we stack up against other countries in regard to the percentage of energy that we are now getting from renewable sources versus what they are doing elsewhere, and how do we stack up against other countries in terms of our investment on research and development, and demonstration versus support for other governments to their industries? Anybody that wants to jump in.

Mr. STERZINGER. Let me start. I am not that familiar with the R&D numbers. Steve may know them better. When you fly into Copenhagen Airport right now, you fly across the harbor and you pass nine or 10 offshore windmills, each about a megawatt, megawatt and a half. The European Union is moving through the sort of regulatory progressions to put in place roughly an 11 percent, 11.2 percent I think it is, renewable portfolio standard, which varies by country. I mean, they have done an assessment of what each country can contribute around that target, and then they have allocated that. And, they are trying to answer the ancillary questions related to that.

Those are major competitors. I don't know what the statistics are, but I would be willing to bet that upwards of three-quarters of the wind turbines sold in the United States were manufactured offshore, either in Europe or in Japan. So I wish I knew the R&D numbers; I don't at this time. But it is clear that in terms of the recognition of the importance of this to their energy markets, one

of our substantial competitors and partners has moved well beyond us.

Mr. TIERNEY. Mr. Bernow, do you have more specifics on that? No? Mr. Little, you have some comments, I think, on the solar end of that, right?

Mr. LITTLE. I know the Japanese budget for photovoltaics is about twice ours, and I think the German budget has now significantly exceeded it, just for the R&D.

Mr. TIERNEY. With the chairman's acceptance, I am going to steal out one of the questions ahead of time here that I saw going through, because it is exactly the same question I was going to ask. It happens to be asked by our State representative from Danvers who was here a moment ago, Ted Speliotis, on that.

One of the reasons I wanted to come to this district and have the hearing, amongst all the other reasons, is that I don't hear a single word being talked about the policy of energy amongst all the many people that are running for statewide office, and I would hope that we have some leaders and some leadership amongst that group who start talking about this and the importance it can be to the Commonwealth of Massachusetts, my district and the other districts that are here in terms of jobs, in terms of investment, attraction of capital, and all of that.

What can States do—while they are waiting for the Federal Government to improve on its performance, what can States do that would mean something favorable in terms of jobs in this regard but would also make a serious impact on what people can save in energy costs, how the State could move away from reliance elsewhere and how we can produce more manufacturing, right on down the line? Mr. Bernow.

Mr. BERNOW. Almost every one of the kinds of policies that we have discussed here that would be affected at the national level, almost all but not all, could be implemented at the State level and some have been, as we have heard, from the renewable portfolio standard to State-level feebates, which are now under discussion, or procurement strategies. There is now a New England energy efficiency initiative, and the aim is to go beyond the Federal level for efficiency standards. Almost every one of those policies and measures that can be enacted at the Federal level can be enacted effectively at the State level.

We are now in a process, a stakeholder process, in the State of Rhode Island, which is supported by the Department of Environmental Management. It has stakeholders from every sector of society—oil people, the utilities, environmental organizations, small business, and so on—in that stakeholder process. We have enumerated measure by measure, across each sector of actions that could be taken by that State and of course by any State that is willing to take a lead that would save money, reduce carbon, transform their energy system into a more cutting-edge energy system, and create jobs, and reduce local air pollution. Again, we have shown that for States just as we have shown it for the Federal policies.

Mr. LITTLE. There are a lot of State programs, including Massachusetts. Massachusetts now has $150 million in a pot for renewable energy. It is being managed by the Massachusetts Technology Collaborative, and they're supposed to really get this moving. It

has been some time because it has been tied up in litigation in Massachusetts. But there is a big pot there; there is a big pot in California. I think the question that was brought up before of how to better coordinate State funds from a national perspective is a good question, and I think more of that needs to be done.

Mr. TIERNEY. Thank you.

Mr. OSE. I want to go back to the cap-and-trade, if I might. Cap-and-trade works on acid rain precursor. Are there other pieces of our air quality dilemma or otherwise, water, soil, what have you, that cap-and-trade might work in? Have you expanded your thinking beyond just the air quality stuff? Mr. Swift.

Mr. SWIFT. Yes. I have done quite a lot of research on this, and not to say that there are not differences of perception and political issues, but the cap-and-trade is currently considered the leading approach for three of the four major power pollutants—nitrogen oxide, sulfur, dioxide, and carbon. I think it is well-suited for those. It is a contentious issue whether you also want to apply it to mercury.

I have in my mind an article titled, "Why Environmentalists Have Nine Reasons to Support Cap-and-Trade and None Against It." There are a number of very fundamental issues this approach resolves, including the problems created by these rate-based standards. The one thing you hear about as a negative is the so-called "hot spots." I have done a considerable amount of research on the issue and as far as I can see, although there is the potential there that requires some regulatory action to prevent, the actual performance of cap-and-trade systems has been to cool hot spots and not increase them. In fact, it is the rate-based traditional systems that create more hot spots than a cap-and-trade system.

Mr. OSE. Could you just expand on what you mean or refer to as a hot spot, please?

Mr. SWIFT. Well, a hot spot is the idea of an emissions concentration. You have to realize that every single regulatory system you can imagine or economic system will create emissions concentrations of—let us take SO2, and it is something you don't want. No neighborhood wants to have an unduly high SO2 concentration.

There are two points to make. The first is that by siting power plants you create emissions concentrations. There is one large power plant in Massachusetts and it is very obvious that is where the emissions are going to be. You then impose regulatory systems, and a trading system in some people's mind creates the specter of you will trade emissions from other sources and put them in one place where they will concentrate. It is a complicated area, but the simplest thing to say is that trading systems tend to provide economic incentives for the larger sources to reduce the most, because they put in capital equipment and that is where the biggest bang for the buck with the capital equipment comes in.

So every system I have looked at, the SO2 program and some of the NOx-based credit programs, you see this phenomenon happening, that the larger sources that are creating the most reductions and the trading disperses emissions instead of concentrating them. But it is a strong perception among the advocacy community that cap-and-trade programs may create worse hot spots.

Mr. OSE. Dr. Bernow.

Mr. BERNOW. I wanted to add on that, maybe take some issue. I support cap-and-trade, especially if the credits are auctioned, but there is nothing intrinsic in the trading system that prevents hot spots, and I think you mentioned a moment ago that to the degree that there might be hot spots, the regulatory process needs to take account of that and make adjustments. I think the emperics so far are, as you say, that there haven't been hot spots, but that is probably, to some degree, the result of the fact that there hasn't been a massive amount of trading. And so, I think it behooves us when we engage in making regulations like this to ensure that we meet the various social goals that we set out to meet. And, since there is nothing intrinsic in trading that prevents hot spots, you should take account of that.

Similar with encouraging distributed generation. You may want to encourage distributed generation for various reasons that were alluded, but certain forms of distributed generation may create their own local hot spot, such as willing diesel or other dirtier forms of DGN. So I generally concur that cap-and-trade with auctioning is a very effective policy, but it may need to be complemented by hot spot or sudden pulse prevention as well as, as you said earlier, the ability of States to withhold and not sell their credits across State boundaries.

Mr. TIERNEY. With the chairman's agreement here, I am going to jump in for a second, because that is a very important area, one of the questions we had on the card in fact deals exactly with this issue. And so if the general feeling is, Mr. Swift, at least from your perspective, that it is not as big a problem as some of the efficacy groups see it, Mr. Bernow you are still in favor of the cap-and-trade thing, then how would you deal regulatorily with those hot spots? What types of things would happen to make sure that it didn't occur?

Mr. SWIFT. I think there are two general sets of tools to deal with hot spots, and I am very much against one of them, which is to impose rate-based standards on each stack. That is what creates your inflexibility, that is what causes your problem. You have got a different set of tools that deal with State power in non-attainment areas. And, from the first days of the Clean Air Act, States are allowed to create what is called a State Implementation Plan, a SIP, that guarantees, or attempts to guarantee, that within your non-attainment area you will not be exceeding your Federal standards. That is a perfectly good idea, it should be encouraged, and States should in fact get more tools to do things. And, there are ways to develop non-intrusive ways of dealing with protecting that non-attainment area. You can also develop very intrusive ways, like mandatory percent reduction rate standards imposed on ends of pipes. So that is the basic protection that you want.

There are other protections that have nothing to do with whether it is cap-and-trade systems or regulatory systems that are rate-based. One is that NOx is produced on hot days—I mean the ozone is produced on hot days, so it is precisely on hot days when people run their air conditioners more. And so, in any regulatory system you will have spikes of more pollution on exactly the worst days. I think in Connecticut, and maybe Massachusetts you have to get

extra provisions to do something on those hot days to prevent precisely that happening.

Mr. OSE. Such as?

Mr. SWIFT. I think Connecticut has a three-for-one allowance reduction system that is triggered on those days. So it costs firms a lot more to emit NOx on those days, so they will differentially produce power from their low-NOx sources. Each firm has a whole bunch of plants they can produce power from at any moment. And so, they will probably go with their modern gas turbine plants which are very, very low NOx and cut out their coal on those days. So it is not a problem, it is not even a big economic problem, but you have got to have the economic signals in there for companies to understand what they have got to do and when to do it. But, again, the design issues are critical. You can do this in an intrusive, costly way, or you can do it in a flexible way.

Mr. OSE. Mr. Sterzinger.

Mr. STERZINGER. I just want to inject, I guess, a little different note on the issue of whether there are hot spots. The United States allows 10.8 million tons of sulfur dioxide to be emitted each year, and that emission is associated with fine particulates. And Apt Associates, a Boston-based consulting firm, has been very active in assessing the health risks associated with those fine particulates, the risk of death from those particulates in particular.

If you look at a map of the United States, you see a sort of concentric set of circles darkening, and it gets darkest on the Southeast, the six Southeastern States, American Electric Power System, Southern, Duke Energy, in particular. That is a hot spot in my mind. The risk of death from that particular condition in those areas is, I believe, 10 times the national average. I support cap-and-trade for its ability to lower the cost of meeting targets, but I think there needs to be a recognition that the journey isn't finished. I mean, we have not answered all of the questions related to not only protecting national standards but also regional, State, and local health issues as well.

Mr. TIERNEY. I guess, help us along that journey then. These things are happening now. People are making decisions about power plants, they are making decisions about levels of pollutants or whatever, so if we are recognizing hot spots, what ought we do now to get us on that journey so that if we go into cap-and-trade system, those areas that consider themselves to be likely to become hot spots don't get penalized?

Mr. STERZINGER. Well, I think there are two—I mean I do not have the complete answer to this, by any stretch of the imagination. I think that you need to develop a system. Mr. Swift referred to having something like a State limit that now relates to NOx, perhaps relate to the other pollutants as well, so that a particular State wouldn't be disadvantaged in terms of their health by virtue of overcompliance in one region. Again, sometimes you need to look at the details. The American Electric Power System overcomplied on a huge coal plant they had in West Virginia, Harrison 4. They put in all the scrubbers, they overcomplied on that plant, they actually overcomplied for their system, in part because the regulatory allowances allowed very quick recovery of the pollution equipment and provided a potential source of revenue for them on the sale of

credits. And so I think they were well set in terms of their system to comply.

If you happen to live in a State with some of those other plants, the system as a whole is in balance, but the pollution that you were subjected to hadn't changed at all. I mean there had been no effect on it. The famous New York case where New York State sued was precisely because of downwind pollution drifting onto the State with Long Island and other utilities buying credits from the very utilities who were sending the pollution onto the State.

So I think there needs to be that kind of State action. We have been really heavily involved with sort of the use of renewables and conservation in the NOx compliance plans. Each State—Georgia is allowed 30,000 tons of NOx. They are approximately 1½ or 2 times over that. They have to come into compliance. The experience from 1990 has been that conservation and renewables have been vastly underrepresented as a solution. Part of that is a problem related to how you qualify conservation, particularly renewables to some extent, as a legitimate reduction in NOx. The other problem is that there is a problem in terms of whether if you do something in a particular State, that State can capture that benefit or whether the plants are simply run and exported out of the State.

There is an awful lot of concern. I think that the health concerns related to the fossil generation is something that is, at least in my experience, in people's mind, almost as great an issue as the security and global environmental concerns. And I think it is legitimate. I think it needs to be addressed very, very carefully.

Mr. SWIFT. And, some of these have been alluded to, but there are several ways to address the limits, hot-spot related or pulse or spike-related issues associated with a cap-and-trade system. One that is mentioned, strong State implementation plans. A second would be a system of augmenting the trading credits at certain times of the year, in certain spots. A third would be States being allowed to retire their credits once they have generated them and not trade them away. A fourth would be some limitations on banking. A fifth would be to establish perhaps State and/or regional programs. As George was saying with respect to RPS, you could do that at the State level, perhaps at the regional level, State and regional areas in which cap-and-trade could take place. And, finally, of course, is to limit overall emissions—to reduce the overall cap nationally to acceptably low levels, which in itself would reduce the hot spots as well as the overall emissions. And there are various proposals that have been put forward for very dramatically reducing SOx, NOx, mercury and CO2 nationally.

Mr. OSE. In California, we had our problems and we had—under the SIP we have different air basins, and we were not able to trade credits from one air basin to another, which tells me that we all may not be able to trade air credits from one State to another in many instances. I don't want to be a doomsayer, but speaking to the future I can see a situation where we have re-created in certain sectors, for certain geographic areas of the country, a replay of what happened in California. Now, if that occurs, how do we keep these credits from going through the roof value-wise and forcing the shutdown of this or that generating plant, whether it be coal or natural gas or nuclear, what have you? I mean nuclear has no

emissions so they are pretty clean in that respect. But the issue becomes whether or not you have to end up waiving your air quality requirements or not. I would be interested in the panel's considered opinion as to whether or not these credits should be tradeable, either one for one or at some discount or premium across air basins or State boundaries. Dr. Bernow.

Mr. BERNOW. Yes. Well, I think I have suggested, and maybe others have, that there could and should be some limitations on that to the degree that is necessary to protect local citizens. I think every State has a responsibility to protect its citizens. And, the tradeoff, ultimately, is between a completely flexible market, which has great advantages in some respects and protecting of citizens in a local community. And, if the citizens in a local community are willing to pay the price of departing from what is seen as, from a market standpoint, the economically efficient solution in order to protect their local health and their local environment, then that is a political decision that they can and should take, of course, with all due deliberation.

Mr. SWIFT. From what I understand of the—I think you are referring to the RECLAIM market in California where prices went through the roof. One of the key elements is that market does not allow any banking and so after a miscalculation by firms in how much it would cost to meet the 2001 standard, there was no escape hatch. Every other system, even the New England NOx system, does allow limited banking, and it just again points to the importance of details in this area. I think you can solve that problem.

Mr. OSE. Dr. Bernow, do you support the banking concept of these credits?

Mr. BERNOW. I support some of them.

Mr. OSE. OK. Mr. Swift, do you support the banking concept?

Mr. SWIFT. Yes. I basically think—well, I mean secretly, I think this whole issue is grossly overblown. I think if you had no local rules whatsoever, everything would be fine, because the whole east coast is one big transport area for NOx. You have basically got the east coast, Houston, and L.A. as outliers. Seventy-five percent of Massachusetts NOx comes from out of State. You can quibble about the 25 percent but I don't want rules to interfere with the functioning of the system, but I will also say that carefully crafted, modest rules that reassure the public for things that may never happen are perfectly OK as long as they don't interfere with the system. So I will go along with limited banking as long as it is not too limited.

Mr. OSE. Dr. Fairman, does the Energy Group have any opinion?

Mr. FAIRMAN. Just, conceptually, nobody in the Expert Group advocated cap-and-trade or other primarily market-based systems to the extent that they would violate public safety or public health standards. These standards are thresholds, they are politically and public health-wise non-negotiable. The whole point of these performance, market-based incentives is to maximize cost effectiveness of pollution control above that threshold. So no one in the group would support any banking or use of permits in a way that violated those thresholds themselves. It is all above the threshold.

Mr. OSE. Mr. Sterzinger.

Mr. STERZINGER. Let me just tell you, I agree pretty much with what has been said so far. I think that the kind of problems you are talking about, the price spikes that can occur, are not to anybody's advantage. They disrupt the market, they don't lead to any sort of long-term solution, and they can undermine support for the environmental standards.

I think it really underscores the need to look for a variety of options. I think we may have been lulled into a false state of complacency with respect to the performance of the cost of sulfur dioxide credits from 1990 on, since they dropped so precipitously. And, I think with the NOx and other pollutants we need to do more work going in to make sure that there is as wide a portfolio of options, including renewable technologies and conservation efficiencies, as possible to make sure that the problem you are talking about of really just coming catastrophically out of compliance with people bidding against each other for an inadequate source of credits doesn't arise.

Mr. OSE. Mr. Little.

Mr. LITTLE. Well, related to this is why does Chicago want a photovoltaic factory? And, the answer is because when they are hot, which is in the summer, when the sun is beating on Chicago, that is when the renewable energy is the most efficient, so it is a perfect match. And, that is one of the reasons the mayor wanted to increase renewable energy within the city itself.

Mr. OSE. I have but one other question, and then I would be happy to yield the time to Mr. Tierney. I just want to get it straight in my own mind—different parts of the country have different embedded advantages for this or that alternative energy source. Are there advantages that exist in this particular area that I, as a Member from California, wouldn't ordinarily be knowledgeable about but need to be knowledgeable about relative to alternative energy sources, specifically here in Peabody, here in Massachusetts? Right, geothermal, photovoltaic?

Mr. STERZINGER. I think offshore wind is something you might not know about that is a potential resource for this State, and it may be underestimated at this time. I mean the ability both of the turbines to increase in size, 2, 2½ megawatts, and the location of possible sites, perhaps not directly on Nantucket roads but perhaps someplace else; I think is a resource that you may not have appreciated.

Mr. OSE. Anybody else?

Mr. FAIRMAN. This may be slightly off point, but just from the experience of the Expert Group talking about the resources conceptually, the idea that the intellectual capital here in the energy efficiency and renewable energy markets supported by Federal RD&D and the university/Government nexus is a huge resource, not just for Massachusetts but for the country. So, just thought I would throw that in.

Mr. OSE. Dr. Bernow? So you have the 128 corridor, you have colleges and universities, something offshore with the wind? OK. Mr. Little.

Mr. LITTLE. Well, solar energy works here as well as it does in Chicago. I wanted to add from the Department of Energy's point of view, I at one point received a contract and gave a subcontract

to an individual formed Eden Semiconductor which is a big corporation in this area, and it grew out of that research and this intellectual environment we have.

Mr. OSE. Thank you. Mr. Tierney.

Mr. TIERNEY. Thank you. I might add that solar has already been shown to work here in this part of Massachusetts, over at the solar facility we have had in the Beverly High School for so many years. Unfortunately, the lack of governmental support for that has jeopardized that program. But it was successful. It fed energy into the city's municipal supply, and it was a great example for the number years it was there. Obviously, biomass, we have a lot of farmland in certain parts of this Commonwealth that could generate that, as they could in a number of other States in the country. The wind offshore is now just beginning to get some recognition around here so that we have a number of reasons why hopefully our State policy as well as our Federal policy will move us in that direction.

I think we have dealt with several of the questions that were asked from people that are in the audience just by virtue of our own line of questioning overlapping some of those. I will say that there are a number of questions on nuclear energy production. I am not a fan of nuclear energy production, and certainly I note that there haven't been any new nuclear facilities proposed for some time, and I think it is unlikely that there will be. The question is how do we move beyond that, or whatever? If anybody wants to make a comment about our nuclear energy and its role in moving forward our energy supplies or the likelihood that it won't be part of a mix in the future after the original plants fade out.

Mr. BERNOW. I would say that the prospects for the next several decades are moving very, very dramatically toward energy efficiency, cogeneration, or combined heat and power, and renewable energy, complemented by some natural gas but keeping natural gas under control would obviate the need for nuclear power in all of the attendant economic and security and human risks.

Mr. FAIRMAN. I just want to highlight in the text of the Expert Group report on page 10, you will see a small box on nuclear power, which represents the summary of a 3-hour conversation, quite intense, among 20 experts on this topic. And, basically, without taking nuclear power off the table, they wanted to be very explicit in saying that nuclear power has been given many, many exemptions from the kind of regulatory requirements and financial requirements that other energy sources are generally required to meet. And, they were quite firm in saying that if nuclear is going to stay in, it should stay in on the basis of being cost competitive with other sources and not with exceptional subsidies and exceptional allowances. They also emphasized that without a stable long-term solution to the waste disposal problem, there is just nothing that is going to happen politically or technically in that sector.

Mr. TIERNEY. Thank you. There are a number of questions about why there is so little funding for renewable energy development and education, and I suspect that is more a political question than for any of the gentleman on the panel. And, the answer is that is just an argument that Congressman Ose and I have to take to our colleagues as well as others and try and be more successful there.

I know that in my opening remarks that the amount that we spend on research and development and education, also pilot programs, things of that nature, has dropped precipitously since the 1978 period down to now. Hopefully we will reverse that. I don't think it has been reversed in the plans that are currently being considered by Congress. I think they are woefully low compared to the money that we still spend on fossil fuel research and things of that nature. But those are also political questions that you probably won't want to participate in.

But I think that the last two parts of it that would address much of what people are asking on the last couple of questions, one would be a little more emphasis on the jobs. If somebody might just want to tell us some practical ways that jobs would be increased? Maybe give us an example or two on that aspect of why people should not be overly concerned with the loss of jobs, that if we have a smart transition program that gives people that are losing their job in the coal industry, for instance, some support, and then where they would go for their next job. Do you want to start left to right or right to left?

Mr. BERNOW. I will start. I think the work that George Sterzinger has done to show the direct economic job benefits of specific renewable technologies is very, very important. The work that I have done and colleagues have done complements that, that shows that if you have a smart set of policies and measures, and again I would echo George, there is no magic bullet here, you have to have a very, very robust set of policies and measures. If energy efficiency and combined heat and power are at the heart of those policies and measures, then that would be a job stimulation program of a fairly deep nature, because you would have all of this money saved by households and businesses that gets re-spent.

That said, and my study shows this, there will be some sectors that in the near term could—the fossil sectors that could, all else equal, suffer some setbacks, and those sectors have both the necessity and the opportunity to be assisted, especially the workers in their transition program in the communities, assistant to transitioning themselves into the modern and cutting-edge clean energy world. And, I think that is true of the oil sector; it is true of the transportation sector; it is true of the electric utility sector. They can be providers of energy efficiency and alternative forms of liquid fuels and not simply stay stuck in coal for electricity generation and oil for transportation. The Government needs to play a role to ensure that the transition is effective and smooth.

Mr. SWIFT. I had a question for you, which was the last time I looked there are only 70,000 coal miners in the United States. It has gone down steadily from 200,000 or 300,000 a few decades ago. I am just perplexed as to why, on the other hand, you can visualize many more jobs doing the clean technologies that we are talking about, but why does the political perception persist that those 70,000 jobs count so much more than the other jobs?

Mr. TIERNEY. I will start first, if you don't mind. We are both going to take a shot at that, because I think we are troubled by it all the time too, why disproportionately—I think all politics is local, obviously, and for the people that may be in very powerful positions in the Senate or the House, there is a great deal of pres-

sure to not have several thousands of people out of work in your district. And, what we have been incredibly lax and seemingly unable to do that we have to do is find a way to make sure that those people don't suffer. This isn't the only issue. That happens in trade. Why don't we move better on trade and free trade? It is not because people don't believe in free trade, it is that nobody has the confidence that we are going to do anything to help the people that are going to be displaced or otherwise inconvenienced severely by this.

So the political issue is there for us to move forward in those directions but to put in place some safety net system of people, not a welfare system, whatever, but a transitional system that helps their families and their communities, because it is always more than just a family. Base closure is another area that we always deal with this on, help them survive that segue into the next area and get them trained and retooled and up and placed into another job where they make as much or near as much as they were making before. I think that is just the abject failure of policymakers so far to make sure that we do these things in tandem, that we don't just talk about energy policy or base closures, recommended by the President or whomever, or free trade, without also talking about what we are going to do with the people that are going to be impacted, because our political situation is such that people do have the power sometimes to slow down the wider public policy based on those narrow issues. Doug.

Mr. OSE. That is a far more comprehensive answer than I was going to give. One thing I have learned on Capitol Hill is to be attuned to the interests of the senior Senator from West Virginia. And, one of the great things about being a Member of Congress is you get to ask questions, not answer them. [Laughter.]

Mr. TIERNEY. But you got it done pretty well, so I got to hand it to you. You got a two-for there. Anybody else want to add on to that? Sure, George.

Mr. STERZINGER. Yes. Let me try to put a slightly different spin on it, because I have heard that, the number, 70,000, 50,000, many, many times. Turn it around, 70,000 workers provide the fuel to provide 22 percent of the U.S. energy sources and even more of the electric sector, which is an enormous productive resource. I mean I think a lot of the reason that goes beyond—I mean I have heard people say, "Well, you know, pay everybody $50,000 a year and you are done with it," I mean just get away with it. But I think it neglects the ongoing importance. There is a real need to reduce the pollutants from coal, to make the use of coal as efficient as possible, but I think everybody would agree that as we go forward that hopefully won't be the major source or perhaps even a growing source, but it will be a foundation of the energy economy.

And I think a lot of times—well, let me just switch. I agree precisely that as you make a transition from one technology to another, first of all, I think it is important if you look at the story of the Energy Information Administration, it isn't coal that is in the cross-hairs of renewable, it is imported LNG, of which there are very few jobs, of which there are substantial security benefits. But I do think it is important to come up with a transition program that is very convincing to the people in those communities that any

move away they will be taken care of and provided with an alternative and productive future.

One thought, one of the great, I think, unintended consequences of the last 5 years of deregulation of the wholesale market is that it has produced a number of unexpected winners. The nuclear plants that were sold for 10 cents on the dollar is one example of plants that are—if you bothered to look at what they were making selling into the deregulated wholesale markets, it is a substantial amount of money. The old coal plants are the same. One way you might be able to—and this is one of the things we get to say without having to deal with the political issues—would be to try to put a windfall profits tax on those sales into the underegulated wholesale markets and use that as the basis for funding some sort of a transition, some sort of productive development or transition program.

Mr. TIERNEY. Just like a rock star, you carry your fans with you. Mr. Bernow.

Mr. BERNOW. Yes. I would like to pull a few things together here. There was some comment that the national dialog didn't want to take a position on the renewable portfolio standard because it was kind of driving toward a specific solution. On the other hand, George pointed out that, at least prima facie, renewables compete with natural gas. But if you put everything together, I think you realize that this is part of a harmonious package. If you want to solve the climate problem but for sequestration that is scrubbing the carbon and burying it somewhere in the ocean and the land, coal is going to have to go in a strong and steady decline over time. There is no solution to that other than sequestration. If coal goes, that is going to pull natural gas in. Renewables then allow you to get rid of coal without pulling too much natural gas in and also stabilizing the natural gas prices. So renewables prima facie may be competing with natural gas, but it is part of the coal/natural gas solution. Renewables, efficiency, CHP, complement a carbon policy and keep natural gas from swamping the system and creating high prices. So they are all part of the package.

And just to finish that package, insofar as—there are some policies that would allow coal units to purchase credits against their carbon emissions. The long-term solution to the climate problem is going to require both the long-term retirement coal units and sequestration of carbon from the atmosphere. It is a very daunting problem, so I don't think one can readily substitute for the other.

Mr. TIERNEY. Three more questions, and then I think we will probably try to bring this to a close. One just concerns the Clean Skies Initiative of the President, and we have covered all this ground.

Do you believe that the caps reduction schedule in the Clean Skies Initiative will substantially drive technological innovation? Mr. Swift.

Mr. SWIFT. My personal opinion is that the levels are in the ballpark that we need to talk about, but the timing is way too long. I think without disruption to the power pool, we need to bring the timing of our reductions closer, and that will drive far greater innovation.

Mr. TIERNEY. Last two questions actually come from the audience but they are things that Congressman Ose and I would have wanted to ask. One is a good question on the impact of the world human population. How can the United States and the world hope to cope with energy issues in a successful and responsible way in light of the rapidly increasing world human population? That is a show stopper.

Mr. LITTLE. Well, I can say that——

Mr. OSE. Before you—we want the short answer, by the way.

Mr. LITTLE. I am always short. I am in business. What we are trying to do with photovoltaics is to keep people back on the farm. And what is the problem with much of the world like Mexico City is that there is no electricity out there so they come into the city, and it becomes a more severe problem. So that is what is, in part, driving the international markets.

Mr. TIERNEY. Mr. Swift.

Mr. SWIFT. I had a quick response, which is that I spend quite a lot of my time in developing countries, and the role of ourselves, the United States and other developed countries, is that we have got to come up with the answers. They do not have the technology or the capital to invest in these high-technology answers we are talking about. And that is where these problems with the lack of research funding and the lack of incentives are magnified many times over. The world is looking to us for the technology answers to these questions.

Mr. TIERNEY. I would suspect that many of these developing countries could leapfrog right over a whole slew of dirty technologies that benefited us, obviously. Not to say that in a denigrating way but that we benefited from greatly, but now, obviously, we find a need to move on. We can avoid that whole problem moving over. Dave.

Mr. FAIRMAN. Just wanted to say that the Expert Group felt very strongly that it is not just their problem, it is our problem, particularly with regard to climate change but with many other issues as well. That is, yes, it is true that—I would agree in part that we have to help find the answers, but there is also the need for doing things in partnership because one of the things that we are learning about, for example, changing the structure of the coal sector in India and China, is that unless we really understand their local political and financial incentives, the technology itself is only about a third of the answer. The second third is the financing, and the third third is the institutions and regulations. But the Expert Group strongly felt that the United States must take a leadership role in this regard.

Mr. BERNOW. I would concur with that precisely. That is our experience throughout the world. One thing I would add that in addition to building the human institutional capacity is that we have got to take the lead in bringing the costs of these cutting-edge technologies down. We can't shift the costs of these cutting-edge technologies for leapfrogging onto developing countries, they just can't take them. So the innovation, the R&D has to be led from this country but then in situ spinoff R&D working with capacity building is the next phase.

Mr. STERZINGER. Just a real quick comment. I just got back from Belize. We are sort of doing an early feasibility study on providing off-grid communities perhaps with solar, perhaps with small wind and then wireless Internet connection so that the bundle of those services is actually both more productive to the community, perhaps producing more income or perhaps in an interesting paradox making something that actually offers more services and is more expensive more easily to afford precisely for the reason that Roger said, which is if you can start to locate economic activity out at the ends, out in the villages instead of having everything concentrated in the cities, you have solved several problems at once.

Mr. TIERNEY. Thank you. And I think we did talk some more about conservation probably after this question was written. Is there anything anybody would want to add about the unique benefits that conservation can add to decreasing the needs that we have or have we covered that ground? All right.

Having covered it, I just want to wrap my comments by thanking every one of you on the panel. Your testimony was excellent, your written testimony was even more involved and developed, and we appreciate the benefit of that. It will go on the record, as will all the other charts and reports that you have submitted. I want to thank the chairman for having the hearing up here in the 6th District. I hope we benefit from that. I noticed some folks from the news media were here and hopefully it will help in the educational process of understanding how important this is, not just nationally but locally here. It can be a great thing for us to both attend to our environmental needs as well as our energy use needs, and creation of jobs for our economy as well as for our health and for the environment.

I want to thank the staff. I know it dislocates them a bit, both the majority and minority side, to come out into the field for these hearings, but it is useful to get out, and I hope the folks from the community were served somewhat by having their questions addressed directly. So thank you, Chairman Ose.

Mr. OSE. You are welcome. I want to add my compliments to those of Congressman Tierney to the people of Peabody for hosting us. I would like to especially make note of the great effort that Congressman Tierney's district and Washington, DC staff did in putting this together. I would like to thank Dan Skopec and Elizabeth Mundinger for joining us here today.

My compliments to the panel of witnesses today. This has been very informative. I want to remind everybody in the back of the room we have copies of all the testimony from each of the witnesses. We are going to leave the record open for 10 days in the event Congressman Tierney or I have additional questions. So we would appreciate timely response to any such interrogatories. Barring any other questions, this hearing is adjourned.

[Whereupon, at 2 p.m., the subcommittee was adjourned.]

[NOTE.—The Environmental Law Institute Research report entitled, "Barriers to Environmental Technology Innovation and Use," may be found in subcommittee files.]

[Additional information submitted for the hearing record follows:]

June 25, 2002

BY FACSIMILE
Mr. Byron Swift
Director, Energy and Innovation Center
Environmental Law Institute
1616 P Street, N.W.
Washington, DC 20036

Dear Mr. Swift:

Thank for your insightful testimony at the Subcommittee's June 17, 2002 hearing, "Energy: Maximizing Resources, Meeting Needs, Creating Jobs." I am particularly interested in your comments on how to improve environmental statutes and regulations in order to promote technological innovation in environmental science.

In your testimony, you state that technology-based rate standards promulgated by the Environmental Protection Agency (EPA) adversely effect technological innovation, the cost of compliance, and the level of clean-up possible. That is, technology-based rate standards inhibit new environmental technologies from being developed, lengthen the time of the permitting process, increase compliance costs, and prevent the use of new innovative equipment that could improve the environment in more cost-effective ways.

Is there a listing of all current technology-based rate standards in EPA's regulations? If not, should EPA or an independent entity like the National Academy of Sciences or the General Accounting Office compile such a listing?

What categories of technology-based rate standards are the most harmful, in terms of hindering technological innovation and increasing compliance costs?

Are regulatory or statutory changes needed to transform technology-based standards to a more effective approach? If so, please provide the Subcommittee with specific recommendations on the types of changes needed.

In addition, are there provisions in existing law that would allow EPA the flexibility to set performance-based standards, rather than technology-based standards?

Please hand deliver the requested information by July 30, 2002, to the Subcommittee majority staff in B-377 Rayburn House Office Building and the minority staff in B-350A Rayburn House Office Building. If you have any questions about this request, please contact Staff Director Dan Skopec at 225-4407.

Thank you in advance for your attention to this request.

Sincerely,

Doug Ose
Chairman
Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs

cc: The Honorable Dan Burton
The Honorable John Tierney

ENVIRONMENTAL LAW INSTITUTE®
1616 P STREET, N.W., SUITE 200
WASHINGTON, D.C. 20036
PHONE: (202) 939-3800
FAX: (202) 939-3868
E-MAIL: law@eli.org
WEB: www.eli.org

July 19, 2002

Doug Ose, Chairman
Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs
Committee on Government Reform
2157 Rayburn HOB
Washington, D.C. 20515

Dear Honorable Ose,

I would like to again thank you for the opportunity to testify before your subcommittee on June 17th in Peabody, MA. I appreciate your interest in designing environmental standards that promote technology innovation and achieve environmental goals at reduced costs of compliance.

I have also consulted with my colleagues at the Environmental Law Institute in response to your letter of June 25th, and would like to provide the following comments.

Question 1: Is there a listing of all current technology-based rate standards in EPA's regulations? If not, should EPA or an independent entity like the NAS or GAO compile such a listing?

No, there is not, although we would broaden the category to include other forms of restrictive standards, which may include specific technology prescriptions in regulations as well as technology-based rate standards.

Question 2: What categories of technology-based rate standards are most harmful, in terms of hindering technological innovation and increasing compliance costs?

The most harmful standard depends on the actual circumstances of specific industries. Generally, rate-based standards are not effective when there is no meaningful ambient limit or cap. There is also a range of restrictiveness of standards, with some like percentage rate reduction standards virtually acting like technology mandates, and strongly affecting technology; better ones like output-based generation standards, and even better systems like emission cap

and allowance trading standards. However, the real answer requires one to look at what is causing an actual problem in industrial sectors right now. For new power plants, the key issue today is the BACT standard for NOx; for drinking and wastewater treatment it is the chlorine requirements; for dry cleaners it is the "dry clean only" label. Each of these could be replaced by overall performance-based standards that promote experimentations and technology innovation.

ELI undertook an interesting survey of industry and government representatives familiar with environmental regulations, and both industry and government respondents replied that they believed that many environmental regulations created these kinds of barriers. Both groups also agreed that the Resource Conservation and Recovery Act posed the greatest number of such perverse barriers, although other major environmental laws were also perceived to contain them. This survey and analysis was published by EPA as *Stakeholder Attitudes on the Barriers to Innovative Environmental technologies.* EPA 236-R-98-001 (June 1998).

Question 3. Are regulatory or statutory changes needed to transform technology-based standards to a more effective approach? If so, please provide the Subcommittee with specific recommendations of the types of changes needed.

Yes, often regulatory or statutory changes are needed. It would be, however, a major research task to undertake to list all such changes needed, or even the major ones. However, the encouraging news is that in most sectors we have studied, we have been able to identify solutions where equal or greater environmental results could be achieved at significantly lower cost. The political problem, however, is building a consensus to get there. The battle over New Source Review and grandfathered sources under the Clean Air Act is one such example - there is no question imposing stringent obligations only on new sources is a major roadblock to innovation investment in new technology, and progress. It places hugely disproportionate costs on new plants and creates major economic incentives for firms to keep producing from existing, more polluting, plants. A system that treated all sources in the same manner would improve the prospects for innovation. A constructive atmosphere is needed to achieve the consensus necessary to replace the existing inequitable, inefficient, and innovation-stifling system with standards that will be more protective, while promoting innovation and efficiency.

The ELI report *Barriers to Environmental Technology Innovation* lists a number of specific reforms that could be implemented. However, it is the product of in-depth, sector-by-sector analysis with extensive interviews with both industry and the regulatory community, which is likely what is needed to expand the list of recommendations. We would be pleased to talk to you about this at greater length.

Sincerely,

Byron Swift
Director
Energy and Innovation Center

The Boston Herald

May 14, 2002 Tuesday ALL EDITIONS

SECTION: NEWS; Pg. 003

LENGTH: 730 words

HEADLINE: Pols tilt at windmills

BYLINE: By ANDREW MIGA

BODY:
WASHINGTON -- An international consortium's plan to build a sprawling offshore windmill farm on pristine Nantucket Sound that has sparked bitter local controversy is now spilling over into the halls of Congress.

Sen. Edward M. Kennedy has quietly won Senate approval for legislation that could spur tough new federal regulatory hurdles for the proposed 40-story tall windmill complex, targeted for a 28-square mile stretch of ocean off Cape Cod.

"I want to ensure that we fully examine the benefits of the project, as well as any adverse impacts it may have on the environment, the local economy, fishermen and recreational boaters," said Kennedy (D-Mass.)

The senior senator's back-door move, despite his neutral public stance, reflects growing concern among key members of the Bay State congressional delegation about the controversial project. U.S. Rep. William Delahunt (D-Quincy), Cape Cod's congressman, said, "We clearly have an inadequate regulatory process here. We need a stronger federal role."

Cape Wind Associates wants to construct 170 windmills - each 40 stories tall - on Horseshoe Shoal, four miles off Yarmouth and eight miles from Martha's Vineyard.

Foes warn the farm could harm prime fisheries, kill endangered birds and cripple tourism, the Cape's economic lifeblood. Cape Wind claims it would provide clean, renewable energy, for up to half of the Cape's electricity needs.

Delahunt suggested that federal officials could force Cape Wind to pay a lease or other fees for its proposed ocean site on public properties - the same way oil and gas firms do.

The project could also present thorny political problems for U.S. Sen. John F. Kerry (D-Mass.), who is touting his environmental record as he prepares for a presidential run. Kerry told the Herald he remains undecided about the project.

The U.S. Army Corps of Engineers and state environmental officials are the only government agencies formally reviewing the plan.

Kennedy inserted a little-noticed amendment in the sweeping energy bill last month for a National Academy of Sciences study of wind, solar and ocean energy development on the Outer Continental Shelf.

The Kennedy study, to be commissioned by the Interior Department, seeks suggestions for tighter regulatory review by federal agencies, possibly delaying or even dooming the project.

Cape Wind, however, said no new laws or regulations are needed. "We're certainly hopeful that no one will put up obstacles and barriers," said Cape Wind president James S. Gordon. "We are undergoing a comprehensive and rigorous environmental impact review by federal and state officials."

But Delahunt said, "This is a particularly sensitive environmental area. You have to make the analogy to oil and gas which have a five-year siting process. This is not something that should be decided by the Army Corps of Engineers."

Kerry agreed that more rigorous federal review must be considered to safeguard the public's interest. But he is also a champion of renewable energy technologies such as wind power.

Senior partners of Cape Wind gave $ 5,000 to Kerry's campaign in November and December.

"We don't want to create layers and layers of bureaucracy, but we want an appropriate, thorough vetting process," Kerry said.

Federal agencies cite a regulatory gap in the case of renewable energy projects such as offshore wind farms not covered under current law.

"There is not a good process in place for projects like this," said Dian Lawhon of the Interior Department's Minerals Management Service. Lawhon said her agency is closely monitoring the Cape proposal.

The Kennedy amendment, backed by the Senate Democratic leadership, is expected to be approved by a House-Senate conference committee sometime this summer. Kerry is a member of the conference panel.

"I'm all for it," Kerry said. "That's the kind of analysis we need. . . . People are raising the issue of whether there is a federal role here."

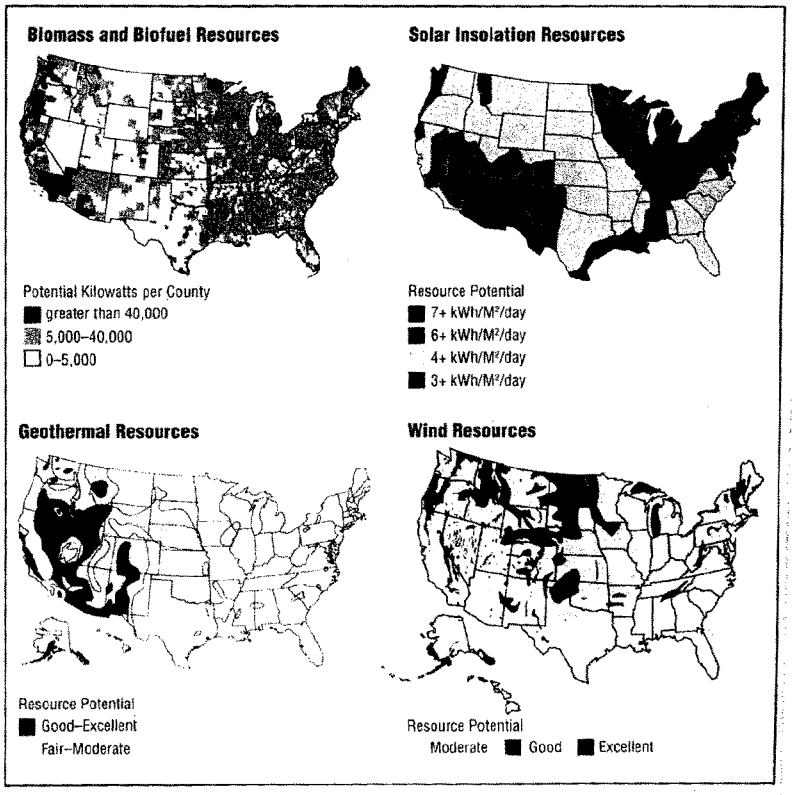
Caption: DELAHUNT: Cape Cod's rep wants 'stronger federal role.'

Caption: KERRY: Senator backs wind power, unsure on project.

Caption: POWER PLAY: Unlike North Palm Springs, Calif., above, a wind farm on Nantucket Sound may not be at the end of the rainbow for developers. AP FILE PHOTO

Graphic: Map of Nantucket Sound, showing proposed location for the windmills. Source: Cape Wind Associates; STAFF GRAPHIC BY JEFF WALSH

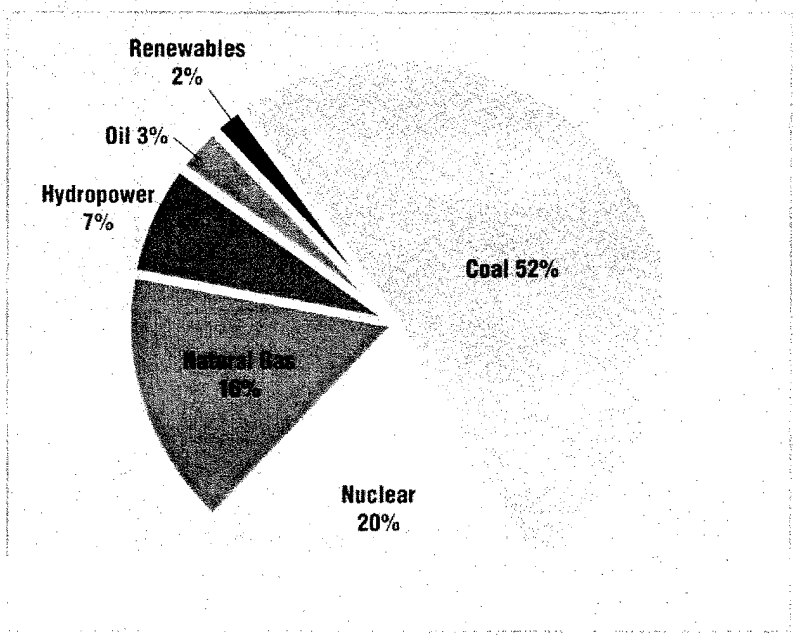
Figure 6-1
U.S. Resource Potential for Renewable Energy



Almost every state has the potential for wind energy and for biomass and biofuel production. The Southwest has the greatest potential for solar energy, and geothermal energy resources are most abundant in the West.

Source: U.S. Department of Energy, National Renewable Energy Laboratory.

Figure 5
Fuel Sources for Electricity Generation in 2000



Electricity is a secondary source of energy, generated through the consumption of primary sources. Coal and nuclear energy account for nearly 75 percent of U.S. electricity generation.

Source: U.S. Department of Energy, Energy Information Administration

FROM : BrightWork Inc FAX NO. : 781-639-0622 Jun. 27 2002 02:10PM P2

HealthLink
Linking Health and the Environment

4 Sewall Street
Marblehead, MA 10945
www.healthlink.org

Fax: 781.639.8667
Phone: 781.639.8636
HealthLink@attbi.com

Congressman Doug Ose
Congressman John F. Tierney
Committee on Government Reform
2157 Bayburn House Office Building
Washington, DC 20515-6743

June 27, 2002

Dear Congressmen Ose and Tierney,

On behalf of HealthLink, we are submitting the following comments in response to the Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs hearing on energy policy held in Peabody, Massachusetts on June 17, 2002. We would like to thank you for holding the hearing in the district and for raising an issue of such national importance. We fully agree that a national energy policy is needed and are generally supportive of the comments by the presenters at the June 17, 2002 hearing.

Overall goals:

The goals of any energy policy must address all stages and impacts of energy production, including sourcing, e.g. mining and drilling, and disposal of all waste streams, and the health and ecosystem costs. Goals include:

> Protection of the physical health and safety of the public
> Reliability and 100% locally sourced "fuels", such as wind and solar
> Preservation of the landscape and ecosystems

These goals may seem impossible, but with a long term view, transition plans with short term milestones, and investment in new technology, we believe they are achievable.

Leaders in the industry have already redefined their business from coal and oil to energy production. For example, on October 7, 2001 Phil Watts, the chairman of Royal Dutch Shell outlined two scenarios for the future. The first is an "evolutionary" carbon shift from coal to natural gas to renewables and the second is a far more dramatic shift from carbon-intensive fuels to hydrogen. Coal, oil, and nuclear power do not fit the energy business of tomorrow and energy companies themselves recognize the future will be radically different.

Response to "Cap and Trade" Testimony:

Regarding the testimony submitted by the panel on June 17, HealthLink has specific requirements for the "cap and trade" schemes favored by Steve Byron of Tellus Institute and Byron Swift of the Environmental Law Institute. The argument that free markets will force the most cost efficient clean up nationally ignores the overwhelming data that pollution is most concentrated closest to the source and causes the greatest exposure and harm to the citizens living near by these old plants.

Studies including those conducted by the Department of Epidemiology School of Hygiene and Public Health at Johns Hopkins, "An Assessment of the Health Risks Due to Air Emissions from the Centralia (Washington State) Power Plant in August 1997 and the Harvard School of Public Health "Estimated Public Health Impacts of Criteria Pollutant Air Emissions from the Salem Harbor and Brayton Point Power Plants (Massachusetts) in May 2000 document the respiratory, cardiovascular and premature death tolls from power plant pollution. The Harvard study says, "Per capita health risks were greatest near the power plants and decreased with distance from the source." The two Massachusetts plants alone were estimated to cost the region $1.05 billion each year in health impacts! The National Academy of Science estimated that 60,000 newborns are born with neurological damage from mercury exposure every year.

US citizens pay an enormous price every year for the pollution that trespasses into our bodies from these old, deadly power plants.

The only way a cap and trade system would protect communities closest to the plants would be to have truly protective caps for each facility and include rate of emission requirements of no more than 1.5 lbs/MWH for NOx and 3.0 lbs/MWH for SO2, specific limits on mercury and a national approach to limiting CO2. In addition to the rate based output system, caps for each facility should be required to insure plant expansions do not undermine rate cuts. At least a 75% cut of the average emissions for the years 2000, 2001 and 2002 for SO2, NOx and mercury should be required for each facility.

Energy Policy and Regulatory Issues:

Currently, the EPA is proposing new rules within the Clean Air Act that will increase pollution and thereby increase death and disease amongst the American public. This is totally unacceptable and undermines the intention of Congress. An energy policy that focuses only on availability and not the costs of health care is incomplete. Instead of this attack on our own citizens, Congress should be passing legislation to reduce pollution and shift the fossil fuel and nuclear subsidies to clean renewable research and energy conservation and efficiency.

In addition, the energy policy must harmonize with the Clean Air Act. In 1970, Congress passed the law based on the assumption that the old power plants would be moth balled by now and replaced with cleaner, healthier generation facilities. The industry, seizing a profitable loophole, has kept the old stock going to the detriment of the country's health.

While the industry complains about the complexity of the New Source Review (NSR), they increase pollution, their profits and our health costs. It should be very simple: any changes to a generating unit that increases pollution should require the installation of modern control technology. The fact that pollution is increasing is indicative of the abuse of Congress's intention that air pollution be reduced, not increased over time.

Transition Possibilities:

Energy generation is understood to be a necessary component of our life style and economy. However, there is no excuse to kill people in the process of its generation. Clean renewables do not create disease-causing pollution, violate our ecosystems or poison our drinking water with their waste. Transitions to a clean portfolio is only a matter of time. To facilitate such a transition, we recommend the following approach:

Short term:

1. Pass the Allen Bill requiring all old power plants to clean up. This legislation has the advantage of providing vitally important transition subsidies for towns and workers affected by plant closures.

2. Shift subsidies in the budget from nuclear, oil and coal to clean renewable energy, conservation and efficiency over time.

2003: 10%
2004: 10%
2005: 20%,
2006: 20%
2007: 40%

To work, these subsidies must include long term (minimum 10-15 year) commitments in order to attract investment capital which requires assurances of a revenue stream sufficient to generate an adequate long term return on investment

3. Use Federal tax or other incentives to promote the installation of solar panels and "green building" technologies and materials on all new construction and building renovations. These should be required for all Federal construction projects.

4. Increase CAFE standards for cars, trucks, buses and construction equipment substantially starting with 2005 models and provide significant tax incentives for consumers to purchase hybrid and other super fuel efficient cars starting in 2003.

5. Develop employment transition plans for mining, drilling, processing and generating employees adversely affected by job loss from outdated industries.

6. Promote energy efficiency and conservation through higher efficiency standards for appliances, minimum standards for all federal buildings and community educational programs.

7. Provide incentives to promote distributed power to minimize the costs of transmission infrastructure expansion, to increase transmission efficiency and to encourage small producers to resell excess power into their local grids.

Long term:

Set goals that a specific percent of energy is generated from clean renewable sources nationally and that total megawatts used is frozen at current levels for the next 10 years to incent conservation and efficiency. For example, by 2020, 20% of all US energy should be from clean renewable sources, with a goal of 100% by 2050.

Conclusion:

The first priority of any US policy, be it energy or anything else, should be to protect its own citizens from harm. While we fight bioterrorism from abroad, Congress' inaction to require the clean up of our energy sector results in its sanctioning of the dumping of millions of tons of deadly pollution on the public. The US Government has a stake in energy and should be taking a leadership role in forming a vision and road map to implement a major change. We cannot rely exclusively on "free markets" to find solutions. Finally, we must face the fact that as long as elected officials accept campaign contributions from the energy sector, judgments about what is best for the country may be impaired. Without leadership and resolve, we will fail. Leading this needed change is a huge task, but necessary and attainable.

On behalf of HealthLink,

Jane K Bright,
Member, Board of Directors

Congress
of the
United States
House of Representatives

JOHN F. TIERNEY
MASSACHUSETTS
SIXTH DISTRICT

July 1, 2002

Dear Chairman Ose:

Attached please find information to be included in the official record of the Subcommittee's hearing of June 17, 2002 held in Peabody, Massachusetts on the subject of Energy: Maximizing Resources; Meeting our Needs; Creating Jobs.

Sincerely,

John F. Tierney
Ranking Member

COMMITTEES
EDUCATION & THE WORKFORCE
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SUBC ON EMPLOYER-EMPLOYEE RELATIONS
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120 CANNON
WASHINGTON, D.C. 20515
(202) 225-8020
http://www.house.gov/tierney

HAVERHILL (978) 469-1942
LYNN (781) 595-7375

17 PEABODY SQUARE
PEABODY, MA 01960
(978) 531-1669

Op-ed

Energy: Developing a Plan
By John F. Tierney

America must pursue a policy making it independent of Middle East oil over the next ten years. This problem of too much reliance on unstable (and too often unfriendly) sources is joined with the threat of catastrophic climate change, which is humanity's great environmental challenge.

The U.S. imports 48% or the 19.7 million barrels of oil per day consumed. No major new oil fields have been found for decades; production has been falling since 1970 and is expected to continue, meaning the share of imported oil will grow to 62% by 2020 if we continue use at present rates. Oil from the Alaskan National Wildlife Refuge would contribute only about an additional 1% to the U.S. share of world reserves. Two-thirds of the world's oil lies in the Middle East. As long as the U.S. needs large amounts of oil, we shall be beholden to regimes like those in Saudi Arabia, Iraq, Iran and others.

With the Bush Environmental Protection Agency's recent report acknowledging warming from man-made conditions the debate is no longer about whether a problem exists, but rather over how severe the warming will be and what will be the specific impacts on different places in the world.

We can address this dual dilemma. The means to a safe and sound energy future are advanced, energy-efficient and low carbon technologies, and the way is through smart public policy.

We can and should reduce oil consumption with vehicle efficiency and new fuels. Carbon Average Fuel Economy (CAFÉ) standards have resulted in nearly doubling new passenger car fuel economy between 1975 and 1998, and in increasing the fuel economy of light trucks by 50%. In 2000 alone, they saved the country 60 billion gallons of gasoline and over $90 billion.

Mandating standards for appliances (refrigerators, air conditioners, etc.) that require manufacturers to meet reasonable targets of reduced energy consumption per unit has huge implications. Just those standards already "on the books" are estimated to save consumers over $150 billion in energy costs by 2020.

Renewables offer incredible promise. Biomass, wind power, some forms of hydropower, photovoltaics (solar), and solar thermal technologies are abundant and available all around the country. They are tremendously popular with the public (a Gallup poll in November 2001 found 90% support for investments in wind and solar power).

Electricity generated by wind turbines is the fastest-growing electricity source in the world and is growing at a rate of 25% per year. One industry analyst forecasts worldwide sales of over $30 billion over the next five years.

The energy contained in plants and organic matter – biomass – is used to generate electricity, heat homes, fuel vehicles and provide process heat for industrial facilities. Exploitation of biomass energy would be a boon to rural economies. The Department of Energy estimates that tripling the U.S. use of it would provide $20 billion in new income for farmers and rural communities.

The cost of solar power – photovoltaics (PVs) – has fallen by 90% since the 1970s. PVs are used to insulate buildings and reduce heating and cooling costs. One recent study predicts that solar panel costs will fall from $5.12 per watt now to $1.75 per watt by 2020.

There are numerous other examples of technologies being pursued, like geothermal energy use and including use of new materials that improve enormously the efficiency of buildings and industry.

Our abilities to respond to energy challenges will depend in large part on how much effort we put into R & D. This effort cannot be left to the private sector alone. It is an important funding partner, but the pay-off dates are often too far out to attract private capital; the benefits, as mentioned, are often public rather than private; and the benefits may not even accrue to a particular firm.

Unfortunately, R&D on energy is declining, with U.S. federal spending plummeting from $6.55 billion in 1978 to under $2 billion in 1998. In that year, the President's Committee of Advisors on Science and Technology recommended doubling of R&D over 5 years, concluding that our programs were "not commensurate in scope and scale with the energy challenges and opportunities the 21st century will present."

Long-term, flexible and firm standards to improve efficiency and reduce carbon emissions throughout the economy – coupled with increased, focused spending on R&D – can bring about necessary changes at low cost. Increasingly, America's business community is joining the fray with companies like Dupont, Johnson & Johnson, Suncor Energy and others making commitments to energy efficiency and cleaner use goals. More often than not, these goals are being met sooner than the target dates originally set, and the companies are saving, not losing, money on the efforts.

Getting to the point where we have transformed our energy policies to best deal with environmental and security concerns will not be easy and it will not be instantaneously done. Still, if we encourage the best technologies and couple their use with implementation of sound standards fairly applied we can realize a clean, secure energy future.

Jun.27. 2002 11:22AM MarineFisheries No.2736 P. 2/3

Commonwealth of Massachusetts
Division of Marine Fisheries
Annisquam River Marine Fisheries Station
30 Emerson Avenue
Gloucester, MA 01930
(978) 282-0308
fax (617) 727-3337

Paul J. Diodati
Director

June 26, 2002

Representative John F. Tierney
Massachusetts Sixth District
House of Representatives
Congress of the United States

Re: Public Comment on Alternative Sources of Energy

Dear Representative Tierney:

I wish to offer comments regarding your public call for input on alternative energy sources. My perspective comes from my position as a marine fisheries biologist for the Massachusetts Division of Marine Fisheries, serving the region of Hull to Gloucester. I applaud your efforts to seek technical solutions for reducing our dependence of fossil fuel combustion for energy. Instead of providing ideas on what to do next I want to offer another reason on why it is imperative that we develop a focused Federal plan for alternative energy generation.

There are many powerful arguments why our nation's dedication toward burning fossil fuels for domestic energy and locomotion is not in the public's long-term interest. Human health, global politics, economics and environmental impacts are all major areas of concern. Under the topic of environmental impacts, I want to voice a concern that has become apparent to me after working in your district's rivers and estuaries for 15 years. The threat of eutrophication is growing in estuaries and rivers along Massachusetts Bay. High concentrations of nutrients (primarily nitrogen and phosphorus) are moving from watersheds to sensitive habitats in our estuaries. It is possible that the high tidal amplitude of Massachusetts Bay is diminishing the threat from nutrient inputs in the harbors and embayments. But my observations and monitoring indicate that habitats and resources further up in the estuaries and freshwater interfaces have clearly suffered from eutrophication during the last two decades.

The degradation of spawning habitat of anadromous fish is one specific example of this concern. These fish run up into freshwater habitats in the spring to spawn. They need clean water and substrate for eggs to survive. Their spawning habitat of choice is often at junctions that bear the brunt of watershed stormwater inputs, of which nutrients are a major concern. My experience indicates the quality of these spawning substrates is declining and the excessive growth of algae from high nutrient concentrations is a

contributing factor. The spawning habitat of anadromous fish and other aquatic organisms may seem to be of little concern, but these resources do contribution to the sustainability of important commercial and recreational fisheries and have irreplaceable ecological and cultural value.

Emissions from fossil fuel combustion are certainly contributing to high watershed concentrations of nutrients. Fossil fuel emissions contain large concentrations of nitrogen constituents. Recent studies in the Chesapeake Bay and Buzzards Bay regions have indicated that atmospheric deposition of nitrogen can account for a fourth to a third of total nitrogen inputs to watersheds. We have to be concerned about the relationship of fossil fuel emissions (for toxins and acidic deposition as well) to atmospheric deposition in eastern Massachusetts with the extensive land development, dense transportation corridors, and several old, inefficient power plants.

The U.S. Environmental Protection Agency along with the Massachusetts Department of Environmental Protection has done a very good job reducing the pollution inputs from point sources in recent decades. And they are presently working to address the impacts from stormwater or non-point sources in the watersheds. The trouble is these efforts alone won't mitigate for nutrient, toxic and acidic contaminants that come from atmospheric deposition. Without strong congressional leadership on this topic I fear that these specific habitats and natural communities will continue to suffer from pollution contributions that originate with fossil fuel combustion.

This is but one small concern in the discussion over our stubborn dependence on burning fossil fuels. I hope you received many comments on human health and other environmental concerns, as well as innovative ideas for correcting our course. In addition to all the ominous concerns that truly threaten our quality of life, I just wanted to make a case for these natural habitats and resources that are degrading before my eyes.

Sincerely,

Brad Chase

Bradford C. Chase
Marine Fisheries Biologist
brad.chase@state.ma.us

cc:

Eric Hutchins, National Marine Fisheries Service, Gloucester, Ma.
Anthony Verga, Ma. State Representative, Gloucester, Ma.
Salem Sound 2000, Salem, Ma.

PATRICIA PIERCE
SITE ANALYST CONSERVATION ADVOCATE
8 Tarr's Lane West, Rockport, Mass. 01966
Tel. 1-978-546-6483

June 27, 2002

Representative John Tierney
U.S. House of Representatives
Congress FAX ~~202-225-3121~~ 202-225-5915
Washington, D.C.

Dear Representative Tierney:

Thank you for your leadership in seeking energy conservation products. I was not able to attend your workshop in Peabody of June 17, 2002 but am submitting a written comment.

First, may I suggest that you plan to fund construction of working prototypes. I hold several patents in energy conservation building construction systems that I have been working on since 1982. DOE is no help. They fund nuclear only.

My patents issued in early 1990 and I have met with various corporations who are willing to provide materials but no assistance in prototype construction. They prefer in-house products. After much effort I gave up.

At this writing I have a client, the Greenhouse School of Salem, Mass. who need an energy conservation roof. I recommended that they FAX you a copy of their proposal for funding their roof, which they did yesterday.

The intention of my patents is to harvest energy incident on all peripheries of any building. My patents do not use solar panels, they form the entire surface of the structure and may be mixed with ordinary building products to form appealing exteriors.

The basic design may include PV cells to make the building totally self-sufficient. Inventors need support beyond the constitutional protection of rights to their intellectual property. They need financial support to make a useful product a reality. The private sector, the large corporations, are not a source of funding for prototype construction.

I hope you may have some actual help for the Greenhouse School prototype roof. They have a wonderful ambiance for learning for children who are from the ghetto, literally. This new roof is a sparkling addition to their lives and to new products for a free energy future. The market for sports and indoor pool structures is huge.

Patricia Pierce

Best wishes, Patricia Pierce

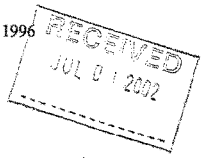
CRYSTAL SYSTEMS

CRYSTALS AND TECHNOLOGY FOR INDUSTRY

June 27, 2002

U.S. Rep. John F. Tierney
Massachusetts, 6th District
17 Peabody Square
Peabody, MA 01960

Facsimile #978 531 1996



Dear Congressman Tierney:

I am responding to the request for ideas on promoting renewable energy that I saw in the Boston Globe June 23, 2002 edition. Crystal Systems has been involved in the development of Photovoltaic (PV) energy since 1976.

The PV industry is undergoing rapid growth with shipments of about 400 MW of PV modules in 2001. This represents a 40% growth rate for last year, and it is projected to increase more rapidly as people become educated in the benefits of PV power. The PV industry has grown steadily and is now a major industry. Almost 90% of worldwide production of PV modules uses crystalline silicon; thin film technologies constitute about 10% of the production with the majority of it for consumer electronics applications. However, most of the government-funded R&D is currently for thin-film technology and not crystalline silicon which is the heart of the industry. The PV industry has matured, but it still relies on the semiconductor industry for rejects and scraps as feedstock. The PV industry is, therefore, dependent on the by-product of the semiconductor industry, and this stifles its growth. Therefore, it is important to have a low-cost solar grade (SoG) silicon feedstock for future growth of the PV industry.

The key to continued growth of the PV industry is the availability of low-cost, large-volume silicon in purity suitable for PV application. It is, therefore, imperative for government funding to be directed toward R&D to develop technology to produce low-cost silicon melstock for PV applications.

Enclosed is a paper entitled, "Production of Low-Cost Solar Grade (SoG) Silicon Feedstock," that was presented by Crystal Systems at the 29th IEEE Photovoltaic Specialists Conference in New Orleans, LA, May 20-24, 2002.

I look forward to receiving your comments on the above. If you need any further information please contact me.

With kind regards,

Frederick Schmid
President

FS/lp

Enclosure

27 CONGRESS STREET
SALEM, MA 01970-5597
978.745.0088
FAX 978.744.5059
www.crystalsystems.com

Preprint
29th IEEE PV Spec. Conf.
New Orleans, LA May 20-24, 2002

PRODUCTION OF LOW-COST SOLAR GRADE (SOG) SILICON FEEDSTOCK

Chandra P. Khattak, David B. Joyce and Frederick Schmid
Crystal Systems, Inc., 27 Congress Street, Salem, MA 01970

ABSTRACT

A simple refining process of blowing moist gases over molten silicon removed high segregation impurities, especially B and P, and reduced other impurities. Using this process with heavily B-doped (HI-B) silicon scrap from electronic industry will double the feedstock available to the PV industry short term. When the refining process is followed by directional solidification it can be used for upgrading metallurgical grade (MG) silicon to produce Solar Grade (SoG) silicon. For the long term, total processing in an MG silicon production plant can result in $10/kg SoG silicon feedstock..

INTRODUCTION

The photovoltaic (PV) industry is undergoing rapid growth with shipments of about 400 MW of PV modules in 2001 [1]. This represents a 40% growth rate for last year, and it is projected that worldwide shipments of PV modules this year will increase by about 55% to 620 MW [2]. This growth rate is considerably higher than the 25% annual growth rate projected for the industry only a few years ago [3,4]. The cumulative module shipments worldwide reached 1,836 MW in 2001 [1]. Therefore, the PV industry has grown steadily and is now a major industry. Almost 90% of worldwide production of PV modules uses crystalline silicon; amorphous silicon and thin film technologies constitute about 10% of the production with the majority of it for consumer electronics applications.

Even though the PV industry has matured, it still relies on the electronic industry for its silicon feedstock. Currently, excess capacity, rejects and scraps from the electronic industry are used as feedstock. For the electronic industry, the cost of silicon feedstock is less than 5% of the device cost, whereas for the PV industry it is about 30% of the module cost. Therefore, it is important to have a low-cost solar grade (SoG) silicon feedstock for the PV industry. If an independent low-cost source of SoG silicon becomes available, the growth of the PV industry can increase at a faster rate.

This paper discusses short-range and long-range options for producing low-cost SoG silicon feedstock specifically for the PV industry, which is independent of the electronic industry.

DEFINITIONS OF SOLAR GRADE SILICON

Development of SoG silicon has been pursued in two major areas: (a) variation of electronic grade (EG) silicon production using chemical processing, and (b) upgrading metallurgical grade (MG) silicon production. Advances made in the chemical processing route have benefited the electronic industry by lowering the price of EG silicon, but this price is still too high for PV applications. By using the chemical processing route, all impurities are reduced to <1 ppba level. Most solar cell processing requires silicon with about 0.5 ppma boron (B). Therefore, B dopant is added when EG silicon feedstock is used. It is also recognized that high efficiency solar cells can be produced even when metallic impurities are in the 0.1 ppma range. In view of these criteria, the feedstock can contain higher levels of impurities than EG silicon feedstock without compromising solar cell performance.

An alternative approach for producing silicon feedstock for PV applications is upgrading MG silicon. This material is typically of 99+% purity, and the predominant impurities are Al (12-4000), Fe (1600-3000), Ti (150-200) and Ca (400-900 ppma). The B and P levels are not controlled but are generally in the 20-60 ppma range. It has been recognized that other than B and phosphorus (P) most impurities can be reduced substantially using directional solidification. Therefore, if directional solidification from the melt is adopted, the problem impurities are only those which have high segregation coefficients, viz., B, P and Al, with segregation coefficients of 0.8, 0.35 and 0.003, respectively. Upgrading MG silicon in the past has included using high-purity starting materials during manufacturing of MG silicon [5-7], hydro- and pyro-metallurgical refining [8,9], high-vacuum refining and plasma-arc reduction of impurities [10] prior to directional solidification of molten charge. None of these processes has reached commercialization because B and P could not be removed effectively and/or at low cost. It is generally agreed that if an effective B and P reduction process can be developed, upgrading of MG silicon will be the most effective approach to producing low-cost SoG silicon. The EG silicon feedstock is specified at <0.1 ppba B and <0.1 ppba Donors. The SoG silicon with 0.5 ppma B, 0.05 ppma Donors and <0.1 ppma metallic impurities can be used as feedstock by most processes, with some processes having even more tolerance for impurities. This specification of SoG does not compromise solar cell performance. Therefore, upgrading MG silicon offers the potential for low-cost production of SoG silicon.

DEVELOPMENT OF SoG SILICON

It is recognized that commercially-available MG silicon has very high impurity content. However, any hydro-metallurgical approach to leach out impurities will require crushing the MG silicon to a finer particle size and resorting to the hydro-metallurgical technique. This approach can result in contamination during the crushing step and create hazardous waste. It was felt that the hydro-metallurgical technique for reducing impurities was not practical, especially in large-scale production. The simplest approach for producing SoG silicon was melting of MG silicon, refining to remove high segregation impurities such as B, P and Al, followed by directional solidification to remove the low segregation of impurities. Since the directional solidification step is important for removal of a large number of impurities, a Heat Exchanger Method (HEM) furnace was used for development of SoG silicon. The HEM furnace offers one of the best directional solidification processes, but a refining step needs to be incorporated to remove the high segregation impurities. A modified HEM furnace was used to demonstrate upgrading of MG silicon to produce SoG silicon. A schematic flow diagram of the approach is shown in Fig. 1.

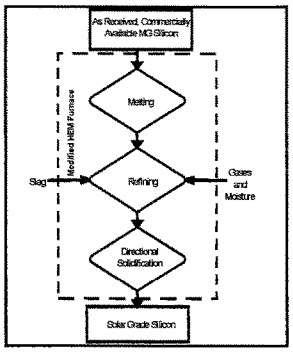


Fig. 1. A schematic flow diagram of the approach to upgrade MG silicon to SoG silicon using HEM.

An effective reduction process was developed involving blowing moist gases to refine B and P and most other impurities. After the refining step the charge was directionally solidified. Using commercially-available MG silicon charge, the B concentration was reduced to 0.3 ppma, P concentration to <7 ppma, and other impurities to <0.2 ppma [11,12]. In this material, the P concentration is still high and needs to be reduced further. Currently, the resultant material is n-type due to the high P concentration. Most solar cell manufacturers require a p-type substrate. It is necessary to develop a more effective P reduction process so that commercially available MG silicon can be upgraded to produce low-cost SoG silicon.

While a more effective P reduction process is being developed for MG silicon, the B reduction process can be utilized with high B-doped silicon scrap (Hi-B scrap) currently available in the electronic industry but which cannot be utilized by the PV industry due to its high B concentrations. This scrap typically is very high purity and contains 50-400 ppma of B. The simple B reduction process was applied to Hi-B scrap silicon, and a 50-kg charge was refined in a modified HEM furnace. The charge after refining was rapidly solidified eliminating a controlled directional solidification as this material does not contain other impurities. This material was used as feedstock for Czochralski (Cz) growth at the National Renewable Energy Laboratory (NREL). For Cz growth, the results showed 14% performance for material using refined Hi-B silicon scrap compared with 14.1% for material using EG silicon [13]. No problems were encountered in crystal growth or solar cell processing.

PRODUCTION OF SoG SILICON

A plan to produce SoG silicon for the PV industry can now be set up using current technology in a stepwise fashion leading to full-scale commercialization. This plan involves a three-step approach, namely, (i) production of feedstock using Hi-B electronic scrap, (ii) controlled production of upgraded MG silicon, and (iii) large-scale production of upgraded MG silicon.

Production of SoG Silicon using Hi-B Electronic Scrap

The electronic industry produces silicon crystals for wafers with various doping specifications. Many devices require wafers with >1 ohm-cm p-type resistivity. The tops and tails of these crystals, reject crystals and surplus supply are used by the PV industry as feedstock. However, a growing segment of the electronics market utilizes devices involving epitaxial growth. Such devices dictate that the wafer be of low resistivity with specifications of <0.05 ohm-cm p-type. The scrap from such ingots cannot be used by the PV industry and is currently being sold to the metals industry at prices similar to MG silicon. This material is very high purity except that the B concentration is 50-400 ppma. It has been demonstrated that this high B concentration can be reduced to acceptable levels for the PV industry. When the material was used as feedstock, high-efficiency solar cells could be fabricated13. Prototype production of this technology using Hi-B scrap silicon as starting material for production of SoG silicon would require only the refining step. A prototype furnace designed with this B refining technology could handle charges between 500-1000 kg. This material after refining could be supplied to the PV industry, and based on results, the prototype production can be optimized. Full-scale production after the prototype stage could nearly double the supply of SoG silicon to the PV industry in the short term. While there are some approaches being pursued to solve the long term problems of supply of SoG silicon, there are no additional sources for the near term. This approach could bridge the gap to allow growth of the PV industry and evaluate use of refined silicon as feedstock.

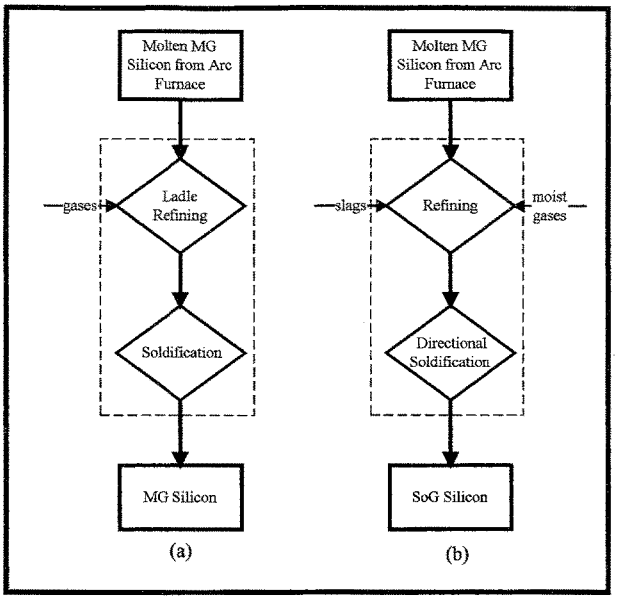


Fig. 2. Flow diagram of (a) conventional production of MG silicon and (b) proposed refining approach to produce SoG silicon in an MG silicon production plant.

Controlled Production of Upgraded MG Silicon

It has been demonstrated that P concentration can be reduced to about 7 ppma from the original concentration of 20-60 ppma in commercially-available MG silicon. This P concentration is still too high for production of high-efficiency solar cells. The P concentration can be reduced by adopting additional stages/refinements in an MG silicon plant to reduce P concentration or continue moist gas refining for longer periods or developing a more effective P reduction step so that after refining P concentration is reduced to <0.05 ppma. Development work along all of these approaches can be pursued to reduce P concentration in MG silicon. If an effective P reduction process is combined with the simple B reduction process, the SoG silicon can be produced by upgrading MG silicon. Once details of the refining are developed, a prototype refining furnace to handle a 500-1000 kg charge can be set up to optimize the process and supply samples to the PV industry. Based on results, a controlled production of SoG silicon by upgrading MG silicon can be undertaken to supply feedstock to the PV industry.

Large-Scale Production of SoG Silicon

Once the refining approach of upgrading MG silicon to produce SoG silicon is accepted by the PV industry, it is intended to set up large-scale production of SoG feedstock within an MG silicon production plant. In this approach, MG silicon will be tapped directly from the submerged arc furnace into a refining furnace instead of the currently-used ladles. The refining furnace will have the capability of using moist gas treatments with molten silicon for extended periods as it will be installed with a heat source. Use of gas treatments in a ladle is routinely carried out in MG silicon plants; therefore, this technology will be consistent with their facilities and capabilities (Fig. 2). After refining, the molten silicon can be directionally solidified to remove other metallic impurities. With this approach, the molten MG silicon can be tapped into the refining furnace on an as-required basis rather than setting up a new facility for producing high-purity MG silicon. As the demand grows, increasing amounts of MG silicon can be refined to produce SoG silicon feedstock. At that stage, improvements can be carried out in the production

of MG silicon so that high purity MG silicon is produced which will make the refining process more effective.

CONCLUSIONS

For the first time, a simple process of blowing moist gases over molten silicon has shown that the high segregation impurities, especially B and P, can be removed effectively and other impurities are removed substantially. Using this approach with commercially-available as-received MG silicon, the B concentration has been reduced to levels required for SoG silicon. Utilization of this approach with Hi-B scrap silicon from the electronic industry can result in almost doubling of the feedstock for the PV industry in the short term. Longer range, it is necessary to develop a more effective P reduction process which, combined with the B reduction process, could produce SoG silicon in large quantities so that the PV industry will have its own supply of SoG silicon independent of the electronic industry. The procedures developed for refining are compatible with the operations and facilities of MG silicon production plants. Therefore, it makes sense to eventually transfer the SoG silicon production to a MG silicon plant where molten MG silicon from the submerged arc furnace will be refined and directionally solidified to produce SoG silicon. This approach is expected to yield SoG silicon at about $10/kg. An advantage of this approach is that it offers an incremental progress and does not require a major SoG silicon plant investment to demonstrate the full potential of the process.

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SEEE SOLUTIONS
Neil Chase

SCIENTIFIC Economic Ecologic Energy SOLUTIONS

407 Locust Street, Danvers MA 01923
Tel: 978 985 2767

House Reform Committee
Sub-Committee on Energy Policy,
Natural Resources and Regulatory Affairs
B377 Rayburn HOB
Washington, D.C. 20515

I am submitting two proven technologies that stand to revolutionize our current energy impasse of pollution and dependency.

Water can now be employed as a safe non-polluting, inexpensive fuel for the operation of internal combustion engines and furnaces. The extremely efficient Carbon Arc Gasification Process is patented as to process and devices by two retired electrical engineers with whom I have been working as a consultant for the past several years. They are self-financed and of necessity seek funding to complete the expensive third party testing and verification of their meticulous work, which commenced years ago. I have witnessed their automatic carbon arc generator in operation and have video footage of a Ford vehicle and a pontoon boat as well as several electrical generators operating on this unique sin-fuel which has a BTU value of 1170F to 1200 BTU's per cubic foot compared to the average 1,0405 BTU valuation for Natural Gas.

The generation process for converting polluted water such as sugar waste solutions or sewage solutions relies on the intense 7000 F temperature generated by the familiar and traditional carbon arc employed in welding and cutting metals. Our use of this standardized technology is employed by submerging the arc in a variety of water based solutions containing organ carbon such as alcohol, waste sugar products from bottling companies or citrus drink producers.

The carbon arc once "struck" consumes a relatively small D.C electrical current. Testing has proven that increasing the current there is a significant increase in the gas production rate by as much as 40% and beyond. The same increase in gas production occurs when pressure and temperature are increased under the Le Chaltier Principle. To date we have achieved a 412% increase of electrical energy input when compared to gaseous energy out. Some might call this an over unity situation but in actuality it is a far more efficient method than electrolysis for extracting some of the "potential energy" from a biomass solution containing organic carbon. Water has been scientifically judged to contain an Energy Potential that is 300 times that of gasoline! Hence a gallon of gasoline contains 1 20,000 BTU's and a gallon of water contains the potential energy of 36,000,000 BTU!

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407 Locust Street, Danvers MA 01923
Tel: 978 985 2767

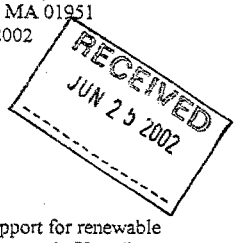
The Biomass Gasification Process is infinitely superior to electrolysis as to efficiency and applicability.

The Carbon Arc Gasification Process produces a safe, nonpolluting, in expensive organic fuel with a wide variety of applications, from on board fuel generation for all manners of vehicles from cars, busses, and trucks to boats planes and power plants. This process can also be employed as a giant energy storage device or battery. We have proposed to no avail as yet, that the excess hydro electrical power generated in New York's upstate 23rd district be purchased at the going rate of 1cent per KW hr during off peak hours which would be used to generate gaseous fuel which in turn would be easily stored for use during peak power needs when the electric rates is 12 to 13 cents per KWhr. In addition this gas has many potential uses in the synthetics industry because it is a hydrocarbon derived from organic biomass.

Before signing off I should mention the work another group has accomplished in revising and producing the far more efficient and lesser expensive Bourke Detonation Engine (BDE) which delivers the same horse power using half the fuel of today's engines plus a clean exhaust of water vapor and half the CO2 as well as 1/5 the waste heat. This engine dates back to the 1930's when Russell Bourke, who served in both World War I & II, set his considerable genius to fully employing the second stage of combustion known as Detonation which for the past 100 years has been feared and avoided as it literally blows apart the standard conventional Internal Combustion Engine (ICE). Today's engines rely totally on the Oxy Carbon Burn Cycle that produces a flame front speed of approximately 100ft per second. The second unemployed phase of combustion is the explosive Oxy-Hydrogen Detonation Cycle with a flame front speed of 5000 per second or 50 times that of the 100-year-old conventional Oxy-Carbon burn Cycle. The Buorke Detonation Engine (BDE) has a long list of advantages that are the result of the superior engineering that hopefully will replace today's 100yr old Inefficient Incomplete Internal Combustion Engine (IIICE) with its miserable 30% efficiency compared to the BDE's 80% efficiency rating, that produces no pollution and only one half the CO2 and one fifth the heat of the IIICE.

By combining water based fuel with a Detonation styled engine we can give ourselves and our grandchildren a far higher quality of life based on Natures Natural Laws and intentions rather than Profits for the Powerful. There is no time for the wrangling of political parties or the domination of specific commercial interest if we are to preserve our Green Planet as we have been privileged to know her.

2 Fordham Way
Newbury, MA 01951
June 24, 2002



Congressman John Tierney
17 Peabody Sq.
Peabody, MA 01960

Dear Congressman Tierney,

Having read the 6/23/02 Boston Globe article "Tierney gets support for renewable energy push", I would like to add my comments for the Congressional record. If at all possible, I would appreciate a copy of comments as they appear in the record as part of my graduate study.

As a concerned citizen and graduate student of public policy, I firmly believe in the increased use of renewable energy sources and decreased reliance on fossil fuels for security and environmental reasons.

One significant obstacle to a greater share of energy from renewable sources is their current price, which is higher (i.e., cents per kWh) than fossil fuels like coal. To rectify this competitiveness obstacle, European Union countries, especially Germany and the United Kingdom, have implemented many policies and measures. We should follow their path for a safer, cleaner future.

The U.S. should adopt the following market instruments that are proving effective in leading European nations. They include:

- Reduction of coal subsidies to internalize the environmental externality of mercury, sulfur dioxide, and carbon dioxide pollution
- Revenue-neutral carbon tax that exempts renewables and natural gas Combined Heat-and-Power ("Co-generation")
- State and/or federal guidelines and targets for percent shares of electricity and/or total energy supply from renewable sources(for example, the Massachusetts Dept. of Telecommunications & Energy through a minimal per-kWh charge is working toward a 5% renewable electricity share by 2005)
- Higher fuel-efficiency for cars and light trucks, especially SUVs (the European Union has negotiated agreements with European, Korean, and Japanese auto-manufacturers for 40 miles-per-gallon vehicles by 2010)
- Increased R&D spending (rather than the 2001 $1 trillion tax cut and future cuts)

For details on these and other measures, please consult the two below sources.

G8 Renewable Energy Task Force. 2001. Final Report.
Available: www.renewabletaskforce.org/pdf/G8_report.html

Gummer, John & Moreland, Robert. 2000. EU and Global Climate Change: Review of Five National Programmes. Available: www.pewclimate.org/projects/pol_review.pdf

Many thanks for your leadership on this important issue. If I can provide further clarification, please contact me at the above address.

Sincerely,

Matthew Saradjian

Coogan, Tracy

From: webforms@www6.house.gov
Sent: Tuesday, June 25, 2002 3:05 PM
To: Coogan, Tracy
Subject: Constituent Opinion

Date: 6/25/2002

Staffer: Conor

Bill Name/#: Response to Alternative Energy Hearing

Pro/Con:

Title: Mr

Name: William Vachon

Group:

Address: 25 Tappan Street

Town/Zipcode: Manchester, 01944

Daytime Phone: 978-526-7549

Evening Phone:

Statement: Constituent called with comments from the subcommittee hearing last week. He works in the field of alternative energy and power generation through wind turbines and has met and worked with JT on a few occasions, as well as contributed to the campaign and met with the Energy staff.

He wants to stress that the largest obstacle to increasing the erection of wind towers and production of wind power are the rigid zoning laws that exist in the district. Most zoning laws prohibit the erection of a structure above 35 feet, which makes it impossible to build wind turbines without a substantial effort to change the laws regarding the building of free-standing structures.

Zoning laws must be made simpler and more straightforward so that large wind towers may be built. Mr. Vachon looks forward to working with JT on this issue.

Attendees of the 6/17/02 hearing: submissions for the record:

Comments for: Congressman John Tierney's Subcommittee Hearing on Energy 6/17/02
From: Linda Haley, 43 Turner Street, Salem, MA 01970 (978/741-7877)

Federal energy policy is now subsidizing energy technologies and behavior s that pad the pockets of polluting industries and encourage citizen lifestyles that are not sustainable, healthy or economical in anything but the shortest term. What I am requesting is a switch to a free market approach that demands honest accounting practices be applied to the energy business. If we truly paid for what we get, we'd get cleaner technologies and jobs that support them.

Right now the true costs of energy are being paid not by the industries that generate them but by me — a taxpayer. Take nuclear power, for example. If the incredibly high financial, security and environmental costs related to nuclear waste disposal were paid for by that industry, would nuclear power still be considered a "cheap fuel" or a wise investment? Similarly, if coal fired power plants paid to degrade the lives and property values of abutters to coal mines or coal generating facilities, or for acid rain's wider impact on the health care system and the environment, would they still burn coal?

Congress should require all costs related to energy production be included in the price of fuels and other goods, so that federal energy policy can promote, rather than discourage, socially and environmentally benign industry and consumer practices. Business will develop alternative energy technologies, together with the jobs needed to research and support them, because it will be more cost effective to do so. Consumers forced to cover the true cost of gasoline will choose energy efficient vehicles or mass transport over gas guzzling SUV's.

Arguments around energy policy are very confusing. It seems that for every expert opinion, there is an equally valid, opposing opinion. Until last week, for example, when the Bush administration admitted that global warming is for real, there was endless debate between the "conservative" skeptics and the "green" doomsdayers. Now that all concur that we're in trouble, the experts are disagreeing about whether we should work to reduce greenhouse gases or just try to develop new methods to outsmart nature. Congress should do all it can to achieve the former, such as supporting the Kyoto Treaty, while being very suspicious of the latter approach, which promotes building impregnable walls around coastlines or cooling oceans — "make work projects" and corporate welfare with potentially lethal ecological consequences for the planet.

Not that long ago I could drink water from the tap, eat tamale from lobsters caught in Salem harbor and stay out in the sun without applying heavy sunscreen. My family and I need Congress to act boldly to reverse energy policies that protect corporate interests over those of life on earth as we know it. If we cannot eat, breathe or drink , all the riches in the world won't save our country or the robber barons who threaten us with financial disaster if we force them to retool and retrain. I thank for you holding this hearing and for your attention to my comments.

C-10

C-10 RESEARCH & EDUCATION FOUNDATION, INC.
44 MERRIMAC STREET
NEWBURYPORT, MA 01950
"dedicated to radiological monitoring, research, and education since 1991"

June 17, 2002

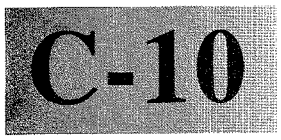
TESTIMONY SUBMITTED BY THE C-10 FOUNDATION AT SUBCOMMITTEE HEARING ON ENERGY POLICY-ENERGY; MAXIMIZING RESOURCES

Post 911, nuclear reactors and their spent fuel pools pose a previously Unimaginable and presently unacceptable risk to the public. Nuclear Energy has become a serious national security issue. Therefore, the C-10 Research and Education Foundation calls for a rapid transition to Phase out nuclear power to safe, renewable, and clean energy sources; enactment of strong government provisions for energy conservation and efficiency; and an aggressive public education campaign to assure democratic participation toward these goals. To avert a national crisis, nuclear power plants near highly populated metropolitan areas must be phased out of service first.

The C-10 Foundation endorses the *National Energy Policy Initiative* and the *Clean Energy Blueprint*, developed by the Union of Concerned Scientists with the Tellus Institute and American Council for an Energy-Efficient Economy. C-10 is committed to building a consensus through public education to support a national energy policy which is secure, safe, clean, reliable, affordable and fair. The Foundation intends to create a dialogue between citizens, the scientific community, elected officials and government agencies to assure a clean and secure energy future.

The C-10 Foundation shares the energy future vision of the *National Energy Policy Initiative* that "the United States, and the world, must begin a decades-long transition to an energy system that will not run out, cannot be shut off, supports a vibrant economy, and safeguards our health, safety and the environment".

TEL: 978-465-6646 FAX: 978-462-3959 WEBSITE: WWW.C-10.ORG EMAIL: INFO@C-10.ORG



RESEARCH
AND
EDUCATION
FOUNDATION
Inc.

The C-10 Research and Education Foundation was established in 1991 to address the health and safety issues related to the Seabrook nuclear power plant. The C-10 Foundation is a non-profit 501©(3) organization that evolved from *Citizens Within The Ten-Mile Radius,* a 5,000 member grass-roots organization founded in 1986 to challenge the evacuation plans for the Seabrook reactor.

The C-10 Foundation's mission is to serve as an environmental watchdog, public health protector and resource on radiation-related issues and alternative energy. The primary function of C-10 is to analyze the impact of radiation contamination from the Seabrook power plant on the residents who live in the communities nearest the plant.

The goals of C-10 are to provide accurate and well researched information to the public, collect and maintain a credible database of radiation levels within the environment, and create a dialogue between citizens, the medical and scientific communities, elected officials, and the government agencies responsible for nuclear regulatory oversight and public safety.

C-10 FOUNDATION 44 Merrimac Street Newburyport Massachusetts 01950 Telephone: (978) 465-6646 Fax: (978) 462-3959

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1. **Independent citizen's monitoring of airborne radiation levels within the ten mile radius of the Seabrook Station reactor.** This includes computerized monitoring sites that continuously record radiation levels minute by minute, around the clock. These monitoring sites are located in private homes, schools and businesses in MA and NH. C-10's monitoring is the only one that records and measures minute to minute readings of radiation levels. Partial funding is received from MA DPH.

2. **Comprehensive program of disease-monitoring and surveillance for the 23 communities within the ten-mile radius of the Seabrook Station reactor.** This program is currently being funded and conducted by the Massachusetts Bureau of Environmental Health Assessment with in-kind services from the C-10 staff. This program tracks increases in certain types of ionizing cancers that may occur over time during the operation of the Seabrook Station reactor.

3. **Sea life (mussel) study near the outfall of the Seabrook Station reactor.** Partial funding for this study is provided by in-kind services and membership dues.

4. **Working directly with science educators in surrounding schools and universities to provide objective and factual information about health effects of ionizing radiation, nuclear waste issues and alternative energy.** This program is conducted by C-10 staff and Board members.

5. **Hosting and directing regional monitoring conferences and public forums.** The most recent series of public forums arose due to growing concern about possible terrorist attacks on nuclear power plants. Tapes of the two most recent forums, "***Nuclear Security at Seabrook Station***" and "***C-10 Evacuation Forum***", can be purchased for $10 each. We also loan tapes as necessary.

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